ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. LII. No. 6. NEW YORK, SATURDAY, FEBRUARY 8, 1908. ISSUED WEEKLY

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NEW YORK
PUBLISHING OFFICE . . . . . 13-21 PARK ROW
CHICAGO
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NEW ENGLAND OFFICE . . . . . 95 MILK STREET
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TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States $3.00
One Year, Canada 4.00
One Year, Foreign Countries 6.00
Single Copy, 10 cents. Back numbers, beyond one month, each . . .25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

Published weekly by the ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York. Charles W. Price, president and treasurer; Stephen H. Goddard, vice-president; H. S. Tuthill, secretary.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879.

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THE RECOGNITION OF PUBLIC UTILITY SECURITIES.

Several bills are now under consideration by the National Legislature at Washington looking to the solution of the problem of difficulty and embarrassment under which the industrial interests of the country are at present laboring. Chief among the bills of great importance which the Legislature is considering is the Aldrich Emergency Bill, which will probably come before the House of Representatives for consideration during the coming week. From several quarters the indication comes that this measure, if enacted in its present form, would not attain the object sought, as most of its benefits would be limited. The fault apparently lies in the want of scope and lack of provision for serving the whole country.

The Emergency Bill, as it now stands, takes into consideration various forms of securities, but does not recognize, as it should, the great value of the securities represented by public utility corporations. On the other hand, banking interests have for some time placed the securities represented by these public utility corporations far in the lead as gilt-edged and worthy of the greatest support. Notwithstanding the appointment of commissions for regulation of these public utility corporations, there is a widespread feeling among those best informed in financial circles that the public service corporations supplying electricity for light and power, and gas for similar service, together with street railway properties, offer an opportunity for investment which is based upon sound beginnings, and which represents potentially the best possible earning power of any industrial to-day.

Under these conditions it is likely that the Emergency Bill will not have the support of a large number of very influential people. If, however, its scope were broadened so that it thoroughly recognized the importance and investment value of these public utility securities, it would have the support of a great body of investors scattered all over the country, and whose holdings, in proportion to the steam railroad investment, are not only comparable, but make a very good showing indeed. Every one interested in public utility corporations should be alive to the possibilities presented in securing legislation at this time which will include public utility corporations' securities.

We would urge every citizen who is interested in this question to communicate by letter or telegram with his Congressman and Senator. It concerns the public at large as well as the owners of the companies, for in no other department of industrial and financial activity does a closer relation or greater interdependence exist.

AUTOMATIC CONTROL OF RAILWAY TRAINS.

If, along with the construction of electric railways and the electrification of existing steam roads, an improvement in the methods of controlling train movements should be brought about a distinct gain will have been made. Although statistics may show that traveling on railroads is, with respect to other features of our daily life, a comparatively safe way of spending one's time, the fact remains that the total loss of life and limb every year from railway accidents is appalling; and in very many cases the blame can be laid to some failure of the signaling system, and too frequently to a breakdown of the human element. It is possible that in this country accidents due to a failure of the physical equipment are responsible for more deaths and injuries than human neglect, but in England conditions are just the reverse, as has unfortunately been shown by several disastrous accidents occurring within the last few months, each of which was attributed to neglect or disobedience of a railroad employé; and even in this country, during the past year, a number of very bad accidents have occurred, due to the same cause. It would seem that the time is not far off when some mechanism will supplement, if not supplant, the man in the signal tower. Automatic control of the signals themselves by the trains would prevent the signal operator from making a mistake. But the control should not end here; it should be extended so as to prevent the engine crew from disobeying the signals. This control is easy to secure on electric railroads, and is not very much more difficult on steam roads, on which, although the locomotive can not be deprived of its power, the brakes on the train may be set, effectively bringing it to a stop.

A good many signaling systems intended for steam roads, as well as for electric roads, have been devised, and many of them are now being thoroughly tested. These include simple, inexpensive systems intended to control the movements of a small single-track electric road and the elaborate systems in use on the large trunk lines in the country. Some of these are automatic, being controlled by the movements of the cars, but with few exceptions the system stops with the control of the signals alone and the connecting link between the signal and the movement of the car or train is the human brain and hand. Ought not this control now to be extended to the train itself, putting it beyond power of the engineer to run past a danger signal?

The opposition to such an extension of the powers of the signal department of a road is based upon the assertion that no such automatic system is sufficiently reliable; that the train crew would come to depend upon it entirely, and not upon the signals, so that a disastrous failure of the system would be sure to occur sooner or later. It may be admitted that an absolutely perfect system is seldom developed in the laboratory. Practical tests are necessary to indicate what changes and improvements are desirable. And, until such systems are actually tried, it is impossible to say how reliable they are. Many engineers, unfortunately, still look upon the electromagnet as an unreliable device, and the electric motor is thought to be too delicate for such important service as automatic signaling. This is not so, for an electromagnet can be made as reliable as any other mechanical device, and certainly the electric motor has already demonstrated its thorough reliability in railway service. Magnets are now widely used for controlling the equipment of electric trains, and there is no reason why they should not be just as dependable when placed beside the track as when tucked under a car. The objection has often been raised that such apparatus would require much attention. But what system of signaling is there which does not require attention? What engineer would be content to install any operative device whatever and not expect to inspect it frequently, and keep it in the best possible condition?

The objection that the train crew would come to depend too largely upon an automatic train-control system might have more weight if the human element of the present systems of signaling never failed. But it is just such failures that furnish the most powerful argument for automatic control of train movements. Moreover, it is an easy matter to keep a record of the use of the safety devices and in this way find out if any employés are depending upon the system when they should control the trains themselves. The apparatus can be arranged so as to put the engine driver or motorman to some personal inconvenience if he run past a danger signal. This is the case on the New York subway, and a motorman never voluntarily seeks a second demonstration of the operation of the system.

It may be that the time is not far off when some degree of control over the train will be given to the signaling system, whether this be controlled by a man or automatically. There seems to be no sufficient technical reason why this should not be done, and the possibility of preventing disastrous accidents is sufficient to lead to this development.

FOREST PRESERVATION.

It is greatly to be hoped that during the present session of Congress some definite advance may be made toward the preservation of the forests of the Southern Appalachian and the White Mountains. At the present time not only are wasteful methods of lumbering employed, but sufficient care is not given to the forest districts so as to secure the best conditions for re-foresting those sections where the lumber has been harvested. And even in many districts where actual cutting is not going on at the present time, great damage is being done by the pasturing of cattle and by forest fires, against which there is little protection. It is time not only that those having to do with the forests should be taught how to take better care of them, but that some legislative action should be taken to prevent further unnecessary destruction. Indeed, it is a matter of concern for the entire country, as the two districts mentioned, and particularly that in the South, are important sources of lumber, and it would be difficult, if not impossible, to secure the proper protection by the individual action of the various states in which the forests lie; and little will be accomplished unless some comprehensive plan can be put in force. The negligence of one or two states,

if the matter be left entirely to them, would go a long way toward defeating the aims of those states which might take some action. Moreover, in many cases it will be found that states are vitally interested in the preservation of the forests of their neighbors. This is particularly true with respect to the equalization of the run-off of the rivers. The control of the rivers is essential if their water powers are to be fully utilized, yet this control may depend upon the preservation of the forests in neighboring states.

There are about 600,000 acres of forest in the White Mountains and about 5,000,000 in the Appalachian district. In the former some steps have already been taken to preserve the forests, but in the latter nothing has been done except on a few private forest preserves. In this district wasteful methods of lumbering are followed. It is a practice to allow cattle to graze at large, thus not only killing all the undergrowth and young shoots, but by beating down the porous covering of the ground the latter is rendered less able to hold the rain as it falls. In this district, also, thousands of acres of forest ground have been cleared for farming, only to be abandoned after a year or two because the soil is rapidly washed away from the hillsides, or in the case of the valleys, covered by sand brought down by the rivers during floods. In the aggregate, large areas of ground have thus been rendered practically useless for farming.

Engineers are, of course, most interested in this matter on account of the control of the many rivers rising in the forests. In the South there is a large area from four to six thousand feet above sea-level where the streams rise, and in their progress to the Atlantic on one side and to the Gulf of Mexico on the other, offer many opportunities for water-power developments. It has been estimated that in the Southern Appalachian district about one million horse-power is represented by the streams. To utilize the greatest part of this it is necessary that the run-off be as uniform as possible throughout the year. The maximum equipment of a hydraulic power station is seldom more than can be fully operated by the minimum flow of the river during the dry season, and as the flow varies very greatly when there is nothing to hold back the water and allow it to run off gradually, by far the greater part of this power is not utilized. Again, when a river is subject to violent floods, the development works must be more expensive to guard against possible damage.

At the present time interest in this subject has been renewed by the bill now before Congress, and only last week an impressive delegation representing those interested in forest preservations visited Washington in behalf of this measure. This delegation included the governors of a number of states. It is to be hoped, as a result of this visit, that Congress will be brought to a realization of the immediate importance of the matter. But those states interested in it, while seeking the co-operation of the Federal Government, should also do what they can to protect their own forests. Every industry affected will be benefited by the setting aside and proper care of large forest areas, with the exception of those few who are profiting temporarily by the destruction now going on. For a number of years past action has been urged, and already a number of influential organizations have expressed their approval of the plan for setting aside large forest areas. The longer such action is put off, the greater will be the destruction and the harder it will be to recover from the damage which has been done.

THE STABILITY OF THE WESTON CELL.

On several occasions during the past year or so contributions to the study of the Weston or cadmium standard cell have called into question the stability of this cell. It was shown that the more recent investigations, which have been conducted in order to devise means of securing closer reproducibility, while leading to good results in this respect, seem to raise some doubt regarding the stability of the cells constructed according to the newer methods. The chief difference between the old and the new methods of construction lies in the preparation of the mercurous sulphate. In the older methods it was prepared by precipitation from a solution of mercurous nitrate. In the latter it is prepared electrolytically. Cells constructed with the electrolytic sulphate, while agreeing well among themselves, have a value a little lower than that of the cells of the older type and, as just mentioned, seem to be somewhat unstable.

Stability is an essential feature of a satisfactory standard cell, being less important than reproducibility only. Indeed, for commercial use it is even more important. A variation in initial electromotive force might be taken care of by comparison with a cell of known value, but unless the cell maintains its electromotive force unchanged from day to day, it can not be considered suitable for every-day use.

For these reasons a note contributed by Dr. Henry S. Carhart to the January issue of the *Physical Review* is of much interest, because it shows that certain of these Weston cells which Dr. Carhart has had under his observation for nearly five years have not varied during that time. These cells were prepared according to the older method during the first six months of 1903. For four years past they have been maintained at a constant temperature in a bath. Comparisons among themselves and with Clark cells—the latter comparisons being made during the past three years—leave no doubt that this group of cells, at least, leaves little to be desired as far as stability is concerned. It seems probable, then, that the instability of the cells constructed by the newer methods can be avoided. This cell must, therefore, again be considered as suitable for a standard, and an effort must be made to locate the trouble which causes the instability.

The cells Dr. Carhart refers to are of the ordinary H type sealed in the glass. The leading-in wires are fused into the bottom of the glass tubes. It seems that no joint made in this way will resist the penetrating power of kerosene oil, but this objection, which is common to all cells in which the wires are fused into the bottom, could no doubt be removed by placing this joint out of contact with the oil, which might be done by surrounding the wires with glass tubes welded to the cell.

Steam or Electrically Driven Auxiliaries.

By Frank Koester.[1]

SINCE the development of steam-electric power plants the question as to whether steam or electrically driven auxiliaries are the better is still a mooted one. The first plants naturally adopted steam as the motor had not been sufficiently developed; but as the improvement of the motor has progressed it has replaced steam in many plants. At the present time the number of plants using each system is about equal, the electrically driven machinery being chiefly in Europe while the steam-driven plants preponderate in America. This is partially due to the fact that in Europe economizers are used to a greater extent than in America where the feed-water heater has attained a high degree of efficiency.

EFFECT OF ECONOMIZERS.

The choice between steam-driven or electrically driven auxiliaries depends principally on the method of heating the boiler feed-water either by exhaust steam or by the boiler-flue gases. In the former case an open or closed feed-water heater may be employed; the exhaust steam of the auxiliaries being used. In the latter case the temperature of the escaping flue gases must be high enough to allow a sufficiently high chimney temperature to create a proper draft, at the same time giving up enough heat to the feed-water to raise it to the desired temperature. In order to overcome the friction caused by the economizers blowers may be installed or the chimney height should be increased twenty per cent to thirty per cent. When using mechanical draft, either forced or induced, the temperature of the flue gases can not be lowered to any considerable extent over that necessary for natural draft, which should not be less than 450 degrees Fahrenheit. This temperature is essential in all cases so as to heat the feed-water to a sufficiently high degree. The claim is frequently made that with the installation of economizers the temperature of the feed-water is raised to nearly 300 degrees Fahrenheit: it will therefore be seen that it is necessary to maintain a high flue temperature.

On the other hand it is sometimes advocated that a low flue temperature be used where blowers and economizers are used. It is claimed that the chimney temperature may be reduced to 250 degrees Fahrenheit which, of course, will materially decrease the boiler feed-water temperature.

From the foregoing it will be seen that in order to derive the greatest benefit from economizers the temperature of the waste gases must be high. This occurs in plants in which the operation of the boilers is uneconomical and those subjected to high overload as well as those in which superheaters are installed. The combination of superheaters and economizers, especially where highly superheated steam is used, is most economical. When obtaining a high degree of superheat, say from 500 degrees Fahrenheit to 600 degrees Fahrenheit (total temperature), the gas temperature must be at least 800 degrees to 900 degrees Fahrenheit, depending, of course, on the type of superheater employed. In a case of this kind the economizer will absorb the otherwise waste heat and reduce the stack temperature to a desired point.

EFFECT OF HEATERS.

In considering feed-water heaters the amount of exhaust steam available will determine the temperature of the feed-water. The exhaust steam of the auxiliaries is practically exclusively used for this purpose. The amount of steam consumed by the various auxiliaries varies from five per cent to ten per cent of that consumed in the prime movers; there are, however, exceptions which run both under and over these figures.

For comparison we will consider a 3,000-kilowatt (normal capacity) plant whose prime movers consume seventeen pounds of steam per kilowatt and whose auxiliaries use 5.9 per cent of the amount consumed in the prime movers. This percentage may be itemized as follows:

	Per cent
Exciters	0.5
Circulating water pumps	1.5
Air-pumps	0.8
Hot-well pumps	0.3
Boiler-feed pumps	1.5
Oil pumps	0.5
Coal and ash handling machinery	0.5
Stokers	0.3
	5.9

With the foregoing conditions 54,000 pounds of water have to be evaporated in the boilers: 51,000 pounds for the prime movers and 3,000 pounds for the auxiliaries. By using the hot-well water (the plant is run condensing) the initial feed-water temperature will be 100 degrees Fahrenheit. The total amount of heat available in the auxiliary exhaust (at atmospheric pressure) is $3{,}000 \times 1{,}000 = 3{,}000{,}000$ British thermal units, which is sufficient to raise 51,000 pounds of feed-water to a total temperature of 158.8 degrees Fahrenheit. It must be remembered that the 3,000 pounds of auxiliary exhaust is condensed in the heaters and removed

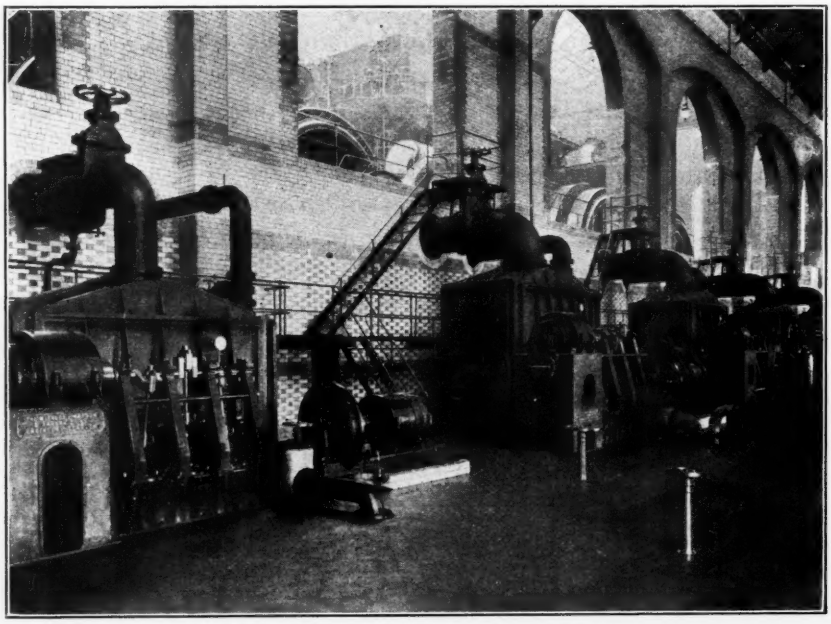


FIG. 1.—MOTOR-DRIVEN CONDENSER PLANT OF THE PINKSTON, GLASGOW, TRAMWAY POWER PLANT.

[1] Consulting engineer, New York city; author of "Steam-Electric Power Plants."

from there to the boilers, therefore does not enter into the calculations.

From this it will be seen that the actual energy used in the auxiliaries is merely

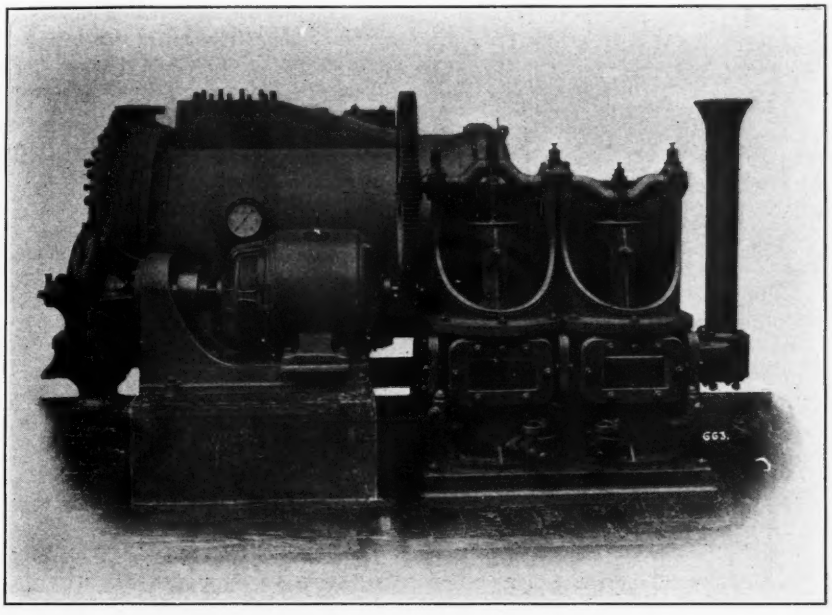


FIG. 2.—MOTOR-DRIVEN SURFACE-CONDENSING PLANT. AIR AND CIRCULATING WATER PUMPS ARE OPERATED BY ONE MOTOR.

that which is produced by reducing the steam from this throttle pressure (175 pounds gauge) to that of the atmosphere.

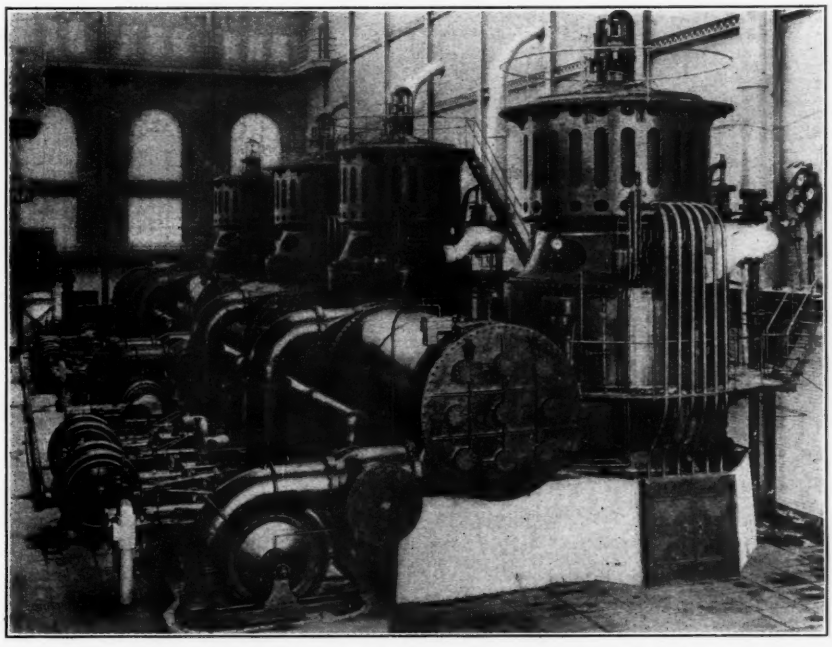


FIG. 3.—STEAM-DRIVEN AUXILIARIES, PORT MORRIS PLANT OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

The amount of heat transformed into mechanical energy will be the difference between the total amount of heat contained in the steam at 175 pounds pressure and the total heat at atmospheric pressure, 1,147 British thermal units. The total heat at 175 pounds, is 1,197 British thermal units, the difference therefore is 1,197 — 1,147 = 50 British thermal units.

As the total amount of steam used in the auxiliaries is 3,000 pounds, the total amount of heat used is 3,000 × 50 = 150,000 British thermal units. Converting this figure into equivalent pounds of steam at 175 pounds, by dividing by the total heat (above 158 degrees) in the steam we have roughly 140 pounds. This is one-quarter of one per cent of the total output of the plant.

Calculating the efficiency of electrically driven apparatus for the same plant under like conditions, the amount of power required must first be determined. Practice has proven that the power used in the auxiliaries of a modern plant with up-to-date appliances runs from 1.5 per cent to three per cent of the total plant output. In the case under discussion we will assume that the auxiliaries require two per cent, which will mean sixty kilowatts, and that the efficiency of the transmission, transformers, motors, etc., is eighty per cent. The steam consumption of the prime movers is seventeen pounds per kilowatt-hour, therefore the actual steam consumption of the auxiliaries will be 20.4 pounds per kilowatt-hour. The total amount of steam consumed by the auxiliaries will therefore be 60 × 20.4 = 1,224 pounds as against 140 pounds consumed in the steam-driven machinery.

The superiority in efficiency of steam-driven auxiliaries lies entirely in the feed-water heater, as it is evident that if no heater were used the steam consumption per hour would be 3,000 pounds instead of 140 pounds.

COMPARISON.

The foregoing treats only of the efficiency of the different apparatus. There are, however, other factors to be considered, *viz.*, first cost, maintenance and convenience of operation.

Considering first cost, there is a very wide range under this heading; for instance, if economizers be used the cost of chimney is largely increased. Also, with electrically driven auxiliaries, additional switchboard apparatus is necessary. On the other hand, if steam-driven auxiliaries be used, the cost of repairing is increased, and, furthermore, it is necessary to use a feed-water heater and oil extractor. The latter is particularly essential to keep the oil from entering the boilers, which not only is a menace to safety, but greatly reduces the efficiency of the plant.

The first cost of a feed-water heater is, however, but twenty-five per cent of that of an economizer.

Summing up the items to be considered with steam drive, we have: Pumps, piping, oil extractor and heater. With electrical drive: Pumps, switchboard, feeder cables, transformers, economizer and additional chimney. The amounts

vary according to the choice of apparatus, locality and the condition of the market.

If economizers are used, the cost of maintenance is in favor of steam drive, but the entering temperature of feed-water is not as high and the ultimate temperature which may be secured with exhaust steam is 212 degrees Fahrenheit. However, this figure is rarely if ever reached. With the use of economizers, however, the life of the boiler is increased, due to the high entering temperature of the feed-water, scaling in the boiler is decreased, as the foreign matter is precipitated in the economizer, and, furthermore, the saving in coal is considerable, particularly where high-temperature, superheated steam is employed. Figuring that the entering feed-water is 250 degrees Fahrenheit against 158.8 degrees Fahrenheit of the steam-heated feed-water, there is a saving of ninety British thermal units approximately per pound of steam. As 54,000 pounds of water have to be heated, the saving in British thermal units is 4,860,000, or, roughly, 400 pounds of coal per hour, assuming high-grade coal be burned and that 12,000 British thermal units be used per pound of coal.

The up-keep, lubrication, etc., is about the same in both cases, while the convenience of operation is largely in favor of the electrical drive.

CONCLUSION.

In conclusion it may be said that steam-driven auxiliaries are cheaper in first cost and more economical in operation, provided that the entire heat of the exhaust steam is utilized for heating feed-water. Electrically driven auxiliaries are more expensive in first cost, but if the waste chimney gases are high, making an economizer practically essential, the cost of operation will be lower.

AUXILIARY MACHINERY.

As before mentioned, the practice in Europe inclines toward electrically driven auxiliaries. Fig. 1 shows a plant of this type. This station operates the Glasgow Tramway and is located at Pinkston, Glasgow. The illustration shows a condenser plant, which is separated from the generating room by a partition wall. It will be observed that the circulating and air-pumps are separately driven and that the general layout and arrangement are of a very neat design.

Fig. 2 shows a surface condenser whose centrifugal and air-pumps are operated by a single motor, direct connected to the centrifugal and geared to the air-pump, which latter is of the Edwards pattern. This air-pump not only takes care of the air, but the water of condensation also.

Fig. 3 represents a typical American power plant with steam-driven auxiliaries, the interior of the Port Morris plant of the New York Central Railroad. The illustration shows a turbine plant with individual condensers. The circulating pumps (centrifugal) and the dry-air pumps are driven by direct-connected horizontal reciprocating engines. Each pump is driven separately. In some stations, such as the Commonwealth in Chicago, the air and circulating-pumps are driven by one engine. The entire generating set is accessible from the main floor, and each turbine, together with its auxiliaries, forms a compact unit. All auxiliary steam and exhaust pipes are laid in tunnels beneath the floor, which materially improves the appearance of the plant. Frequently in installations of this kind the pipes are carried overhead and contribute to the unsightly general appearance of the plant.

Another interesting station where steam-driven auxiliaries are used throughout, with the exception of two exciter units, is shown in Fig. 4, representing a longitudinal section through the pump room of the power-house of the Interborough Rapid Transit Company, located at Fifty-ninth street and the Hudson River, New York. The plant is arranged on the unit system, having one boiler feed-pump, one circulating pump and one air-pump for each prime mover. The pumps are of the vertical type and separately driven, with the steam cylinder at the top. The original intention was to have all the steam cylinders above the main operating-room floor, so as to facilitate operation, but owing to alterations the steam cylinders of the dry-air pumps do

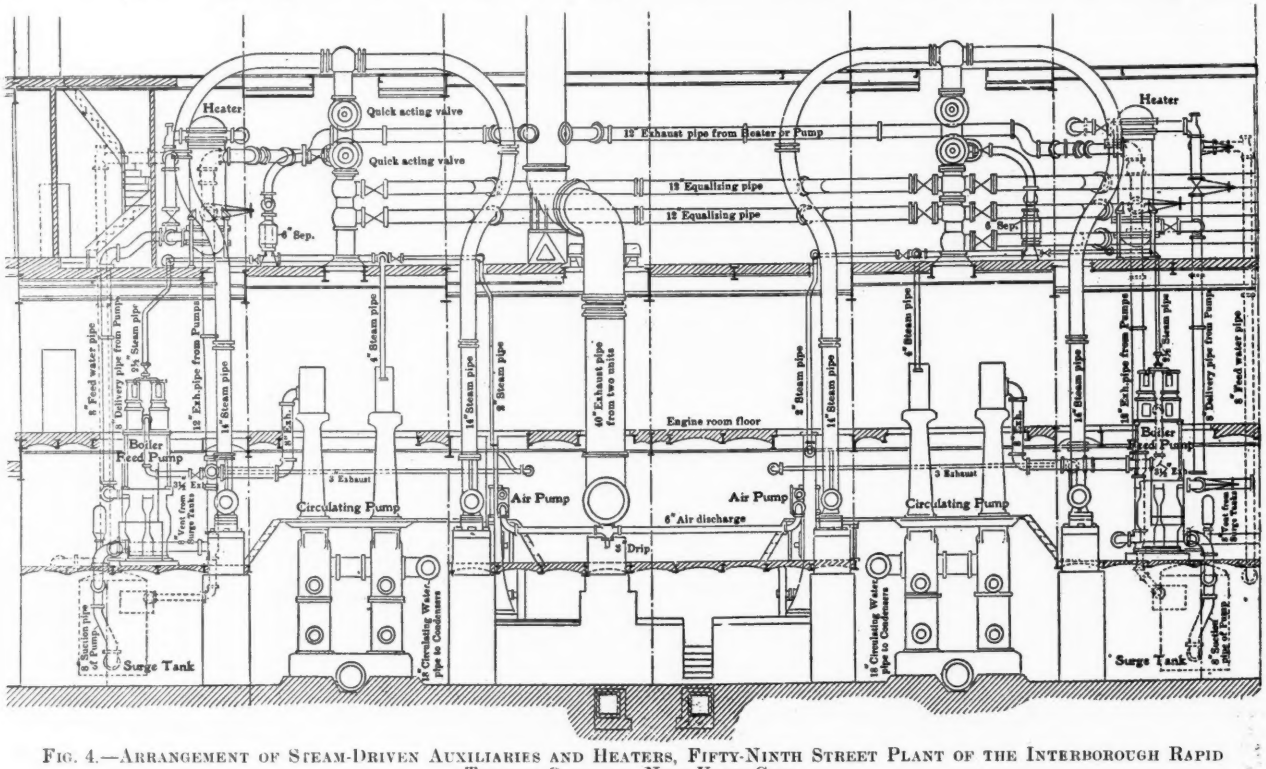


FIG. 4.—ARRANGEMENT OF STEAM-DRIVEN AUXILIARIES AND HEATERS, FIFTY-NINTH STREET PLANT OF THE INTERBOROUGH RAPID TRANSIT COMPANY, NEW YORK CITY.

not project above the floor. The illustration shows closed feed-water heaters located directly above the pumps in the piping room. These heaters have been recently replaced by open feed-water heaters. As there is not sufficient exhaust steam to heat the feed-water to the desired temperature, and as the waste gases of the boilers are highly heated, economizers are also installed, a system which operates under this and like conditions very satisfactorily, although the first cost is extremely high.

Steam-driven boiler-feed pumps are usually of the outside-packed plunger type. However, during the last few years high-speed centrifugal pumps have been employed. These pumps are usually from three to four-stage in order to overcome the high pressure which they have to pump against. They are usually operated by a turbine or other high-speed engine in Europe; as, for instance, in the St. Denis plant, Paris, they are operated by a motor. These pumps are governed by pressure regulators in a similar manner to the steam-driven plunger pumps.

As a motive power for exciters high-speed reciprocating engines are used, and recently turbines have come into favor. In some instances a combination of steam and electrically driven exciters is employed. The steam engines being used at the time of starting, the motor-generator set is cut in after the prime mover is in operation. In some European plants where electrically driven auxiliaries are relied upon the starting current is obtained from an entirely separate source instead of from the main bus-bars. To give more flexibility of operation the feeders should be cross-connected with the main bus-bars.

The American Society of Mechanical Engineers.

The first meeting of the Gas-Power section of the American Society of Mechanical Engineers will be held Tuesday evening, February 11, in the Engineering Societies Building, 29 West Thirty-ninth street, New York city.

The subjects under discussion will be "Experimental Gas Turbines in France" (with lantern slides), "A Simple Continuous Gas Calorimeter," "A Gas Engine and Producer Guarantee." Other subjects relating to the question of gas power will also be discussed.

Government Report on Smoke Prevention.

The United States Geological Survey has issued a bulletin devoted to the government report on smoke prevention. The general statement is made that coal can be burned smokelessly. The purpose of authorizing these investigations is to increase the efficiency and prevent the waste of fuels, especially such as are used by the United States Government.

The following abstracts from this report should be of interest:

"All of the authorities on the subject of combustion and smoke prevention agree upon the following conditions as requirements for a smokeless furnace:

"The coal should be supplied to the furnace in small quantities at frequent intervals. The more nearly the feed approaches a continuous and uniform supply the better the results.

"The air supply should be slightly in excess of the theoretical amount required and be admitted principally through the fuel bed, with an auxiliary supply admitted at the front or rear of the furnace to burn gases from the coal.

"The temperature in the furnace should be sufficiently high to ignite the gases given off from the fuel bed.

"There should be a fire-brick combustion chamber of sufficient dimensions and so designed as to cause the thorough mixture of the gases and the air, permitting complete combustion before the mixture reaches the boiler surfaces.

"The efficiency of the furnace and the degree of success attained by any equipment in the prevention of smoke depend on the skill of the firemen, proper design of the furnace and boiler setting, character of the coal, capacity of the boiler and furnaces, and the load carried.

"Very few firemen can be induced to fire regularly and frequently because it is easier to put in enough coal to last twenty or thirty minutes at one time and have little or nothing to do in the interval between firings.

"The hand firing of plain furnaces violates all the principles laid down for securing good combustion. The coal is usually supplied in large quantities at long intervals and the result is that at the time of firing the temperature of the furnace is lowered, the resistance to the flow of air through the fuel bed is increased, and consequently great quantities of combustible gas which can not be burned for lack of air and the necessary amount of heat are generated. Hand-fired furnaces with ample combustion chambers and adjustable openings for air admission are suitable for some kinds of coal, if tended by careful and experienced firemen.

"Difficulties are also encountered with mechanical stokers. One of the greatest troubles is the tendency of the firemen to poke the fires unnecessarily instead of using or adjusting the attachments provided for feeding and handling the coal. In many plants where it is possible they will shovel green coal into the stokers instead of feeding it through the hopper, and then take a bar and stir up the fresh coal with the coke and ashes, causing smoke and wasting the coal.

"It is generally conceded that intelligent men trained in boiler-room practice could save ten per cent of the fuel used in fifty per cent of the plants of the United States and that in another twenty-five per cent of the plants such men could save five per cent of the fuel. It is the practice of nearly all large power plants to employ a boiler-room expert and many of them have chemists who make frequent tests and investigations to determine the conditions favorable to the best economy. The saving of only a small percentage of the coal consumed will make a handsome return for the cost of the experimental work. There are now in a few of our larger cities competent engineers who are making a specialty of supervising boiler plants for a number of firms.

"This all leads to the fact that the management of the boiler room is a problem for properly trained men and that as the coal burned is a considerable item of expense, averaging about fifty per cent of the cost of producing power, there is more opportunity to save in the boiler room than in the engine room with any given equipment. The average boiler room is a hot, dirty and otherwise unattractive place. For these reasons but little attention has been paid to it by superintendents and operating engineers in moderate-sized plants. The boiler rooms are managed for the most part by men hired not so much for what they know as for their ability to do hard work, and they get comparatively small wages. There are, however, some mechanical appliances which leave but little to the skill of the fireman.

"The increasing use of gas and coke for domestic, manufacturing and power purposes and the centralization of power and heating plants tend to relieve cities of a large percentage of the smoke now being given off by small and inefficient heating or power plants. Notwithstand-

ing the fact that other ways of utilizing coal are growing in favor, it will evidently be necessary to burn coal in small boiler plants for some time to come. These coal-burning plants will continue to keep the problem of smoke abatement before the residents of large cities. It is recommended that to improve the conditions in any city a record of all equipment and furnaces in the power plants be made, and that improvements, methods of operation and the kinds of coal used be made a special study. It is only by such systematic methods that the local problem can be solved, as conditions in any one city are generally different from those in every other city, depending on the amount and kind of manufacturing and the character of the coal available."

The Niagara, Lockport & Ontario Power Company.

An interesting circular has recently been issued giving some of the details of the financing of the Niagara, Lockport & Ontario Power Company. The company has a total outstanding capitalization of $11,001,000. Of this, $2,001,000 is common stock, $2,000,000 preferred stock, $2,000,000 in five-year gold notes and $5,000,000 in bonds.

The property of the company includes duplicate trunk transmission lines, each of 30,000-horse-power capacity, from the Niagara River to Syracuse, N. Y., a total distance of 187 miles, together with eight branch lines of various lengths. The lines are on private right of way, except one of the duplicate lines between Rochester and Syracuse.

Machinery Manufacturers' and Supply Dealers' Convention.

A joint meeting of the committees appointed from the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association, and the Southern Supply and Machinery Dealers' Association was held at the Hotel Jefferson, Richmond, Va., on Friday, January 24, to formulate a programme for a joint annual convention, to be held at Richmond, May 13, 14 and 15. The programme adopted is devoted almost entirely to matters of vital moment to all the interests represented. Speakers of international reputation will present their views, and the speakers drawn from the membership of the associations will make addresses on live topics of vital importance.

Lord Kelvin as an Electrical Engineer.

On the occasion of the memorial exercises in honor of Lord Kelvin, held in the Engineering Societies Building, New York city, by the American Institute of Electrical Engineers, on January 12, one of the most interesting of the addresses made was that by Dr. Elihu Thomson, on "Lord Kelvin as an Electrical Engineer." This address is reprinted herewith from the February proceedings of the Institute:

"Along the semi-arid eastern coast of Spain there is to be seen even to-day a very ancient form of chain pump for irrigation, kept in motion by animal power and bringing up from the well the life-giving water which confers luxuriance upon the surrounding thirsty land, otherwise barren and desolate. A wooden wheel supports a long belt of cord or rope which, wet and in the sunshine, is bleached, and seems to possess a silvery lustre. It carries at intervals along its length earthen vessels, successively brought, full and dripping, from the well below into the full sunlight, suggesting to the poetic fancy burnished gold. Now and then it may be that a maiden from a habitation near by brings a quaint two-handle urn or pitcher to this fountain of life, just as was done in the eastern countries three thousand years ago. Only after seeing all this did I fully understand the beautiful figurative allusion to the close of life in the twelfth chapter of Ecclesiastes:

"'Or ever the silver cord be loosed, or the golden bowl be broken; or the pitcher be broken at the fountain, or the wheel be broken at the cistern.'

"'Then shall the dust return to the earth as it was; and the spirit shall return unto God who gave it.'

"A great fountain of science has ceased to flow, the silver cord is loosed, the wheel is at rest.

"In the recent death of Lord Kelvin the world has lost one of the greatest intellects, a most distinguished student of science, whose attitude was, in spite of his eminence, always that of great modesty. We knew him as the unequaled mathematician and physicist, who was also an electrical engineer of the highest type.

"Withal his disposition was of the most kindly, his personality most lovable. Even to the end of his long and active life of more than fourscore years, his mind was clear; he did not pause in interest; his powers of dealing with abstruse problems did not flag. To those who have had the privilege of personal contact with him, he was full of inspiration, keenly alive to the value of all advances, giving freely of his great store of knowledge. His love for science was only matched by his mastery of its means and methods.

"Others will speak of his lifelong mathematical and physical work, his contributions to navigation, and his pioneer electrical engineering in connection with submarine cables. His cable work was indeed electrical engineering of a high type. It will be my part to draw attention to those other phases of his work which link him closely with the later developments in the electrical field. I can not at the outset forbear to say that in Lord Kelvin were united a deep devotion to science, as such, the so-called pure science, and to the applications of science in industry or engineering. Let his life and work be ever a standing rebuke to those who, few though they now be, forgetting the very dependence of pure research upon the growth of civilization, as a consequence of advance in applied science and material resources, affect to find superior or exceptional merit only in scientific results which are not of practical use. To the man of true genius, such as Lord Kelvin was, the passion for accomplishing things is no more sordid when employed on engineering problems than in pure research, and the two are mutually dependent.

"If we consider the work he did in design and working of cables, studies of capacity and self-induction and the delicate instruments to be used therewith, prototypes of later forms, can we not discover in the great man who has passed from among us the father of modern electrical engineering? History shows that this early work was full of trials, disappointments and difficulties, all arising from mechanical causes, inexperience of men in the making and handling of the cable and the machinery for its manipulation—overcome at last by a perseverance noble in itself. It is too often the case that with new enterprises not only the thing itself but a favorable environment must be created. Neither men, nor tools, nor materials, nor methods exist, or are to be had for the asking. The pioneer has often perforce to cut his cloak to the cloth, and not the cloth to the cloak. James Watt had to be satisfied with engine cylinders which did not vary more than a quarter of an inch in bore from one end to the other, and, so it is said, with a piston packing of old felt hats. So it was when iron wire, cast-iron or highly hysteretic stove-pipe sheet, the latter laboriously fashioned without the modern punch press, for dynamo armatures, had to bring what content

they could to pioneers who knew better, but then could only wish. But this is a digression, and it is only made as an assistance to the perspective in appreciating disadvantages, looking back from the present age of highly developed materials, methods, skill and special tools. It was characteristic of Lord Kelvin's inventive engineering that his conceptions were complete, and when fully worked out gave excellent results in practice. Later work could only affect minor details, and even these he often provided for. He seemed mentally to pursue a problem to the end, and with the result that nothing more could be added later.

"Dr. Nichols may deal with his early interest in the establishment of proper units and standards of electrical measurement, and his connection with the Electrical Standards Committee of the British Association for the Advancement of Science in 1861 and later, which took upon itself the task of establishment of the c. g. s. system.

"It is not surprising that practically throughout his life he gave much attention to the revising of electric measuring instruments and methods of measurement. His absolute electrometer of 1855, followed by the quadrant electrometer, his graded galvanometers of the early period of electric lighting and power, his electrostatic voltmeters and his later Kelvin balances attest his interest, activity and success. Some of these are lasting monuments to his science and skill; valuable alike to the physicist and electrical engineer.

"His visit to the Centennial Exhibition of 1876 was rendered notable from the fact that he was one of the first to listen to the speaking telephone of Bell, there, I believe, originally shown privately, and was the most distinguished witness of the reality of its powers.

"It may be of interest to engineers to recall the fact that in the early eighties Lord Kelvin, then Sir William Thomson, made notable inventions in dynamo machines and took out patents thereon, one of which at least, dated December 26, 1881, was used, together with improvements made by the well-known pioneer engineer, Ferranti, in the Ferranti-Thomson alternating-current machine. It had a disc armature composed of a zigzag tape-winding without iron. This machine existed about 1884 in sizes up to 400 kilowatts' capacity, an unusual output for the time. It was constructed to give 2,000 amperes at 200 volts and light about 5,000 incandescent lamps. The introduction of higher voltages and transformers necessitated remodeling which removed the characteristic zigzag winding from the subsequent great Ferranti generators of the Deptford plant.

"From the early Atlantic cable success it followed that in any large cable enterprise subsequent thereto Lord Kelvin should be consulted. Similarly his great and well-merited reputation brought like responsibilities in other directions. Upon the first serious proposal to utilize the power of Niagara in electrical work he was made one of the International Commission, composed of a number of the most eminent scientists and engineers, which in 1891 was charged with the duty of deciding upon the methods to be followed, and which finally shaped the work of the Niagara Construction Company. The wisdom of the decisions then made has been amply demonstrated in later years. There was at first some question as to whether direct currents or alternating currents should be generated and transmitted. The disposition of the water-wheels, the governing of the same, the type of dynamo construction to be employed, generator voltage, ratios of transformation, frequency, number of phases and other matters of more or less importance required definite selection.

"It must be remembered that the original Niagara plant was created, not copied from existing practice, and therefore was a pioneer enterprise in all substantial respects. Nothing here said can detract from the great courage and merit of the able engineers who were entrusted with the actual construction and installation of the plant. A few words may be said as to the attitude taken by Lord Kelvin concerning the utilization of Niagara power to the detriment of the sublime spectacle of the falls itself. If I interpret him rightly he said in effect that, in his view, there was just as much, or more, sublimity, romance or poetry, as exists in a mad rush of waters over a precipice, in the establishment of a great community making valuable and beautiful products by electric power to enrich the whole world and add to its resources; in the supersedure of oxygen-consuming lamps by beautiful electric lights in all the surrounding territory; in the prevention of the smoke nuisance on railways and in cities miles away, with the incidental saving of fuel for the use of future generations. If this expresses his attitude it is one in which I can heartily concur. Niagara in daylight and in full flow is indeed a sublime spectacle to be preserved, it seems to me, unchanged, provided the sacrifice is not too great, for it has some of the elements of a great conflagration, and moreover it runs on unseen, through fog and night, even the long dark nights of our winter season.

"In bringing to a close this necessarily brief and inadequate statement of the connection of Lord Kelvin with electrical engineering proper, it may be of interest to recall some incidents of a more personal nature. It will be remembered by those who attended the Electrical Congress held in Philadelphia in 1884 on the occasion of the Electrical Exhibition there, that the opening address was made by him. It was not a large body, but composing it were many who are still with us. It was my good fortune to again meet Lord Kelvin in London in 1889, when, as a youthful president of this Institute, then indeed itself youthful, barely out of its swaddling clothes, I endeavored to fitly represent it in a speech at the gathering and banquet of notables and engineers of Great Britain and the visiting American body, in the Guildhall; a combined audience of about 600. I interpreted as a compliment to our young Institute, through myself as its official head, an invitation to visit Sir William Thomson at Glasgow. But my plans had been made, and time was limited, so that to my lasting regret I was unable to accept. But I now cherish as a memory of him one meeting of a few hours in 1897 which came about quite unexpectedly. Lord Kelvin, who was accompanied by his devoted wife, Lady Kelvin, visited this country in that year, and incidentally made a tour of inspection of the shops of the General Electric Company at Schenectady. During this visit those who were with him had an opportunity of discovering his striking ability to seize upon the essential points of a structure, to remark his incisive questions, his quickness and clearness of apprehension, and his untiring interest and appreciation, during some strenuous hours. It was a genuine surprise to us who were with him that in spite of his burden of seventy-three years his mind had retained its alertness and vigor.

"On the trip about the shops he carried a note-book and made frequent memoranda. Some years after this Mr. E. W. Rice, well known to you, visited Lord Kelvin at Glasgow, when at once the note-book was produced, the items of information gone over, and Mr. Rice was questioned as to later developments which were carefully noted, in order to bring the mat-

ters up to date. In the afternoon of the same day I had the satisfaction of finding that I was to be a fellow traveler on the train to Boston, which arrived there in the evening. It is a trip which I have made very many times, and it has generally seemed long and tedious, but not at all so on that occasion. It seemed to me too short. Our talk ranged from details of construction of coils of measuring instruments to the age of the earth, and the nature of ether and matter. Even at the end of the usually tiresome journey, late in the evening, his interest did not abate, for even at the late hour he insisted on visiting the then recently constructed Boston subway before going to his hotel. Lady Kelvin gently protested that he must be too tired, but accompanied him to the subway. To one of his nature nothing that interested him could produce fatigue. The great charm about him was his simplicity of manner and entirely honest attitude as to truth. When he did not know he had no hesitation in frankly saying so, and seeking for information. Later on it fell to my lot to speak some words of appreciation at the meeting held in his honor at Columbia University in 1902, on the occasion of his last visit here.

He had been the recipient of numerous high honors. He was one of our very small list of honorary members, and I am conscious that nothing which I may say could add to the esteem, I might almost say veneration, in which he has been held by all who have known him or known of him. Yet I am thankful to have had this opportunity to express appreciation of him in connection with certain phases of his long and wondrously active career.

Engineers' Club of Philadelphia Elects Officers.

At the regular meeting of the Engineers' Club of Philadelphia, held on February 1, a paper was read by Joseph W. Hunter, State Highway Commissioner, on "Engineering Problems in Road Construction."

The annual election of officers was held on January 18, when the following officers and directors were elected for the ensuing year: President, H. W. Spangler; first vice-president, W. P. Dallett; second vice-president, Washington Devereux; third vice-president, W. P. Dallett; second vice-tary, H. G. Perring; treasurer, George T. Gwilliam; directors, J. T. Loomis, Emile Perrot, Francis Head, J. W. Ledoux, J. O. Clarke, Henry H. Quimby, William S. Twining, James Christie, H. P. Cochrane, Richard G. Develin, Henry Hess and F. E. Dodge.

An Industrial Chamber of Horrors.

The American Museum of Safety Devices, which is organized for the purpose of assembling the best methods and devices for protecting workers in mining, transportation, textile, building trades, agriculture and varied industries, announces that a large insurance company is installing an entire section which will be called "The Industrial Chamber of Horrors." This will show parts of boilers that have burst, elevator chains and cables that have broken, defective bolts and nuts, together with many of the perils of which the general public is usually ignorant. From Germany there will be an exhibit of vials filled with iron, steel, copper, coal, wood and other dusts that are common in various occupations. In connection with this exhibit will be photographic microscopic sections of organizations affected by these different dusts, so that the effect of each may be studied. Wax models illustrating the effect of industrial poisons on various parts of the anatomy will also be shown.

On Tuesday evening, February 11, a meeting will be held at Cooper Union, New York city, under the auspices of the American Museum of Safety Devices, with the Reverend H. C. Potter presiding. Addresses will be made by the Honorable Carroll D. Wright, Rabbi Stephen S. Wise, Alfred J. Boulton, Reverend Percy S. Grant, Dr. Josiah Strong, Dr. William H. Tolman.

The Central Electric Railway Association.

The convention of the Central Electric Railway Association was held at Dayton, Ohio, January 22 and 23. The following officers were elected: President, F. D. Carpenter, general manager Western Ohio Railway Company; first vice-president, A. Anderson, general manager Indianapolis, Columbus & Southern Traction Company; second vice-president, F. J. J. Sloat, division manager Ohio Electric Railroad Company; treasurer, W. F. Milholland, secretary and treasurer Indianapolis Traction and Terminal Company.

One of the most interesting features of the convention was the report of the standardization committee on "Fundamental Brake Rigging," by R. C. Taylor. The recommendation of the committee was that the members of the association adopt on their lines a uniform system of braking gear by which the braking power will be greatly increased and the danger of collisions diminished.

The traffic managers held a session on January 23 and prepared a plan of organization and articles of association. F. D. Norveil, chairman of the committee on traffic organization, reported to the Central Electric Railway Association that the traffic managers would form an association. The articles will be submitted to the managers of the roads before final organization is effected.

Transportation Routes and Systems of the World.

The Bureau of Statistics of the Department of Commerce and Labor has issued a map entitled "Principal Transportation Routes of the World." This shows the chief railway lines and water routes of the entire world, the distances from port to port across all oceans and seas, and carries with it a marginal table showing the distances from New York, New Orleans, San Francisco and Port Townsend to each of the principal ports of the world, and from many of the other cities of the United States to those four initial coast ports.

This map shows that the principal railways of the world are chiefly located in the temperate zone. The total length of the railway lines of the world is given in the document which accompanies the map at 567,000 miles. In some cases, however, these figures are for 1905, and it is approximated that the mileage at the present time is 600,000 miles, of which two-fifths is found in the United States. Of the 600,000 miles of railway in the world, about ten per cent is found in strictly tropical territory, and no more than fifteen per cent within what would be termed tropical and sub-tropical area. The greatest length of railway lines in any tropical country is that of India, including Burma, with 30,000 miles; while tropical and sub-tropical South America has 15,000 miles; tropical and sub-tropical Africa, 14,000 miles; Mexico and Central America, 13,500 miles; the West Indian Islands, 2,500 miles, and the Dutch and French possessions of the tropical Orient, about 1,500 miles each. North America has approximately 260,000 miles of railway, of which 225,000 miles are found in the United States. Europe, as a whole, has about 190,000 miles. Asia has 52,000 miles; Africa, 17,000 miles, and Australia and the adjacent islands of Oceanica, 17,500 miles. The estimated cost of construction or capital cost of principal railways is given, for Europe, at $21,000,000,000 for 176,000 miles, for which statistics are available. Figures of $12,000,000,000 are given for 213,000 miles, for which figures are available, in the United States.

BOOK REVIEWS.

"Specifications and Contracts." J. A. L. Waddell. New York. Engineering News Publishing Company. Cloth. 174 pages. 6¼ by 9½ inches. Furnished by the ELECTRICAL REVIEW for $1.

This work is based on a lecture delivered by the author to the senior class of the Rensselaer Polytechnic Institute, in which he explained the function of the specification and the contract, and discussed the best forms for these instruments, showing why these were suitable and what should be covered in each document. These points were illustrated by quotations from notable specifications and contracts, and emphasis laid upon those features, the neglect of whch leads to unsatisfactory bidding or unplaced responsibility. The book is an illuminating and instructive discussion of this important part of engineering work. It is arranged so that quick and ready reference to different parts which may come up can easily be made by means of side headings. As an appendix to the main part of the book are some notes on the law of contracts, by John Cassan Wait, which contain a great deal of valuable information for the engineer.

"The Mechanical Design and Construction of Commutators." R. Livingstone. New York. D. Van Nostrand Company. Cloth. 94 pages. Illustrated. 5½ by 8½ inches. Furnished by the ELECTRICAL REVIEW for $2.25.

This book is intended principally for draftsmen and engineers engaged in the design of electrical machinery, but at the same time it is an excellent example of the application of mechanics to practical design. The author first discusses the stresses in commutators, beginning with those of the V-ring type, following this a discussion of shrink-ring commutators and then taking up other special types. He gives an elaborate study of the mechanics of the problem and then shows how the formula deduced in this way may be simplified advantageously. The fact that the student has been carried through a complete study prevents him from losing confidence in the short methods which are so widely used in actual design. The study is illustrated by descriptions of standard designs as employed by well-known makers. This book should be of much value to those called upon to design commutators.

"An Introductory to the Study of Electrical Engineering." Henry H. Norris. New York. John Wiley & Sons. Cloth. 404 pages. Illustrated. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW for $2.50.

Professor Norris believes that it is especially important for the student of engineering to approach the subject with some personal knowledge of the things and phenomena which he is to study, and that he should have this knowledge before any reasons for them should be given. He believes that by using the knowledge the student has of electric lamps, electric cars, the telephone and other similar applications of electricity, a solid basis for a general survey of the entire field of electrical engineering is secured. This is the plan of the present work, which is mainly descriptive. It opens with an introductory chapter explaining briefly the applications of the electric motor, the various types of electric lamp, electrochemical action and transmission of intelligence. This is followed by a brief review of the history of electrical development. Next there is a chapter discussing the fundamental electrical and magnetic quantities. The materials employed in electrical engineering are then taken up, from which the author passes to a discussion of electric circuits and magnetic circuits, which is followed by chapters on the construction of electric generators and transformers. The author then discusses the application of these devices in actual practice, beginning with the power station and then taking up the apparatus for utilizing the power which the former distributes. As previously stated, the work is mainly descriptive, and is intended as the foundation for a further analytical study for those students who intend to make a special study of electrical engineering.

"Electrical Traction." Ernest Wilson and Francis Lydall. Vol. i—Direct Current. Vol. ii—Alternating Current. New York. Longmans, Green & Co. Cloth. Vol. i, 476 pages. Vol. ii, 328 pages. Illustrated. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW for $4.

This work is based on a revision of Professor Wilson's earlier treatise on electrical traction. The advances which have been made have, however, necessitated rewriting the book completely, thus producing what is practically a new work. The treatment is largely descriptive. Vol. i gives a brief discussion of the street-railway motor and its characteristic behavior, after which controlling apparatus is taken up, the principles employed and the apparatus itself being described. From this the author passes to details of the car equipment, a discussion of the rolling stock, of the track, systems of distribution, generating stations and repair shops. He then takes up a discussion of the various methods of controlling motors, including the proposed regenerative systems. Vol. i closes with a discussion of the energy consumption on direct-current railways, feeder systems and substations. Vol. ii, which is given up to alternating-current traction, and devotes more space to the fundamental principles upon which alternating-current motors depend and to the design of such motors, since this is a subject which has not been so thoroughly gone into as has the corresponding study of direct-current motors. Along with the study of the various alternating-current railway systems, typical applications of these systems are described. These include the European polyphase installations and the various single-phase equipments in this country and elsewhere. The latter part of the volume is devoted to single-phase commutator motors, the theory of their operation, the methods of construction and their performance. The methods of control and the apparatus used for this purpose are also described with considerable detail. The two volumes constitute a fairly complete discussion of the art of electric traction as it exists at present.

"Practical Physics." A laboratory manual for colleges and technical schools. W. S. Franklin, C. M. Crawford and Barry MacNutt. New York. The Macmillan Company. Vol. i—Precise Measurements in Mechanics and Heat. Vol. ii—Elementary and Advanced Measurements in Electricity and Magnetism. Cloth Vol i, 176 pages. Vol. ii, 160 pages. Illustrated. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW for $1.25 each.

The scheme followed in this manual is that of giving the student a series of more or less distinctly theoretical problems based upon experimental data which they themselves obtained. With this idea in view a number of exercises are set, the object of each is explained concisely, and instructions are given for carrying out the computations and deriving the results. In the introduction to vol. i there is a general discussion of the object of the laboratory work, the proper way of taking observations and preparing reports of errors, the use of curve sheets and other assistants to the work. This volume contains sixty-one exercises, beginning with practice with a simple vernier and advancing through the different measuring instruments to the balance, the thermometer, the clock, the pendulum, the watermeter and the other similar devices.

Vol. ii contains a chapter giving general directions for the use of electric apparatus in which the principles of technical instruments are described. This volume is in four parts: the first giving simple experiments in electricity and magnetism, beginning with resistance measurements by means of a galvanometer and carrying the student through the use of the various types of bridge, galvanom-

eter, etc. This section is followed by advanced electrical measurements, beginning with the standardization of instruments, which is followed by the measurement of specific resistance and magnetization and a few electrolytic experiments. The ground covered is that usually given in the first year's college physics. A valuable feature of these manuals is the clear explanation why the manipulation must be carried out as is described. Too frequently this is not done, so that the student is apt to neglect his instructions, resulting, of course, in the failure of the experiment.

Meeting of the American Street and Interurban Railway Engineering Association.

A meeting of the American Street and Interurban Railway Engineering Association was held at headquarters, in New York city, on January 30 and February 1. The object of the meeting was to outline the work of the various committees for the ensuing year, and the work of the Standardization Committee was taken up first. This committee was instructed to continue with the work agreed upon last year and, in addition, to take up the following group of subjects: "Standard Height of Couplers for City Cars," "Standard Height of Couplers for Interurban Cars," "Standard Automatic Couplers for Interurban Cars and Radial Draft Rigging," "Standard Height of Platforms, "Standard Height of Car Steps," "Bumpers."

A committee of five was appointed on "Economical Maintenance." This committee was instructed to consider the question of what is the most economical method of maintenance, whether taking into consideration the present only or looking into the future.

The Committee on Control was instructed to continue the present line of work and, in addition, to consider the question of the proper method of controlling the rate of acceleration.

A committee of five was appointed to look into the matter of power generation and boiler-room instruments.

A committee of five was also appointed to look into the question of power distribution.

The committees on Maintenance and Inspection of Electrical Equipment, on Way Matters, on Operating and Storage Warehouse Designs and Rules for the Construction of Car Houses, and the Committee on Car and Car House Wiring, were instructed to continue their work and take up such additional subjects as might be relevant to their appointments.

Meetings were also held by the Claim Agents' Association and the Accountants' Association.

Organization Meeting of the American Street and Interurban Transportation and Traffic Association.

At the Atlantic City convention of the American Street and Interurban Railway Association a resolution was adopted suggesting the organization of an affiliated association which would be committed to lines of work pertaining to transportation, traffic and general operation. The executive committee was requested to take such steps as might be desirable to encourage the formation of such an organization. Subsequently a committee on organization was appointed, and several meetings have been held since that time.

On January 30 a meeting was held at the headquarters of the association in the Engineering Societies Building, New York city, with W. Caryl Ely acting as chairman. The first order of business was the adoption of a constitution and by-laws, after which a nominating committee was appointed and a programme committee for the 1908 convention. Upon reconvening in the afternoon the nominating committee reported nominations which were unanimously accepted, as follows: President, C. Loomis Allen, Utica, N. Y.; first vice-president, R. I. Todd, Indianapolis, Ind.; second vice-president, George L. Radcliffe, Cleveland, Ohio; third vice-president, A. W. Warnock, Minneapolis, Minn.; secretary and treasurer, B. V. Swenson. Executive Committee: G. W. Parker, Detroit, Mich.; H. C. Page, Springfield, Mass.; N. W. Bolen, Newark, N. J.; H. A. Davis, Nashville, Tenn.

Executive Committee Meeting of the American Street and Interurban Railway Association.

The regular midwinter meeting of the executive committee of the American Street and Interurban Railway Association was held in New York city on January 31. Those present were: C. G. Goodrich, president; James F. Shaw, W. Caryl Ely, A. W. Brady, F. R. Henry, T. N. McCarter, C. S. Sergeant, F. G. Simmons, H. R. Goshorn, B. V. Swenson, C. Loomis Allen, H. M. Littell and H. H. Vreeland.

The secretary, B. V. Swenson, announced that the active membership on January 30 was 244 street and interurban railway companies, and the associate members on the same date consisted of 184 individuals.

It was announced that invitations had been received for the 1908 convention from the Asbury Park Convention League, the Atlantic City Hotel Men's Association, and from the Denver City Tramway Company, the Denver Convention League, the mayor of Denver and the acting governor of Colorado. It was finally decided to leave this matter in the hands of a committee with power to act, subject to the approval of the president. This committee consists of James F. Shaw, chairman; Arthur W. Brady, Frank R. Henry and B. V. Swenson. It is expected that this committee, in conjunction with a similar committee from the Manufacturers' Association, will investigate the entire matter and make a report to the president some time between now and the first of April.

Annual Dinner of the American Institute of Electrical Engineers.

The annual dinner of the American Institute of Electrical Engineers will be held at the Waldorf-Astoria, Thirty-fourth street and Fifth avenue, New York city, on the evening of Wednesday, February 19, at seven o'clock. Carrying out the idea established upon former occasions, the feature of the dinner this year will be the tribute rendered by the speakers to the relation of the electrical engineer with public service corporations. The occasion will be designated as the "Public Service Dinner," and among the speakers who have promised responses to toasts are many men prominently identified with public service utilities, either as members of commissions or operating heads of large utilities organizations.

The price of the dinner will be five dollars, not including wine or cigars. As usual, ladies will be present. Guests will be seated at small tables accommodating eight persons.

Rossiter, MacGovern & Company Bankrupt.

A petition in bankruptcy has been filed against Rossiter, MacGovern & Company, dealers in second-hand electrical machinery, New York city. Frederick P. Bellamy has been appointed receiver, and has been authorized to conduct the business for thirty days.

The Sanitary District of Chicago's Hydroelectric Development on the Chicago Drainage Canal.

A HYDROELECTRIC power development has just been completed by the Sanitary District of Chicago, Ill., on the Chicago Drainage Canal, with a present capacity of 16,000 horsepower, and having an ultimate capacity of 30,000 horse-power. The power development is located between Lockport and Joliet, Ill., not far from the former city. The primary object of the Chicago Drainage Canal is to divert the flow of sewage from Lake Michigan, purifying the water supply of the city of Chicago. The canal extends from Robey street and the Chicago River, Chicago, to Lockport, a distance of twenty-nine miles, where it discharges into the Desplaines River. This river is an affluent of the Illinois River, which empties into the Mississippi River.

The Illinois Legislature enacted a law creating the Sanitary District of Chicago in 1889, and the work on the Sanitary and Ship Canal was started September 3, 1892, and on January 2, 1900, water was turned in. The canal filled in thirteen days. Its minimum depth is twenty-two feet. The channel is partly cut through glacial drift and partly through rock. From Robey street, Chicago, to Summit, Ill., a distance of about eight miles, the channel is 110 feet at the bottom and 198 feet at the water line. From Summit to Willow Springs, about five miles, the channel is through earth and hard mixture. This section is 202 feet at bottom and 200 feet at the water line. From Willow Springs to Lockport, fifteen miles, the channel is through rock, 160 feet at bottom and 162 feet at water line. The depth of the rock cutting in this section averages thirty-five feet. The grade of the channel is one and one-eighth inches to the mile through earth sections and three and one-quarter inches through the rock sections.

EDWARD B. ELLICOTT,
Electrical Engineer, Sanitary District of Chicago.

The total amount of excavation includes 28,500,000 cubic yards of glacial drift and 12,910,000 cubic yards of solid rock, an aggregate of 41,410,000 cubic yards. One of the most interesting features of the work of construction was the diversion of the Desplaines River. As the plans provided that the channel should follow the bed of the river, it became necessary to excavate a new channel for the Desplaines River about thirteen miles in length. The new channel parallels the main channel throughout the distance mentioned, but about nineteen miles of levee was necessary in order to divert the waters of the Desplaines watershed from the Sanitary and Ship Canal. At the head of the diversion it became necessary to provide a safety valve in the form of a spillway, to allow surplus water to flow toward Chicago. This spillway will be dispensed with when arrangements have been perfected for carrying the entire flood waters of the Desplaines River through Joliet.

In 1903 the city of Chicago and the trustees of the Sanitary District combined to secure legislation providing for the raising of funds by means of a special tax, and the development of power was started in 1904. The original plans for the canal were enlarged so as to provide for a ship canal as far as the power-house. Arrangements have been made for locks to be built later on, and canal locks are now provided for locking boats twenty-two feet wide and 100 feet long, from the channel to the tail-race, which terminates

FIG. 1.—SANITARY DISTRICT OF CHICAGO. VIEW OF POWER-HOUSE FROM DOWN-STREAM SIDE, SHOWING END OF LINE, LOCKS AND MOVABLE DAM. THERE IS 300,000 CUBIC FEET OF WATER PER MINUTE PASSING OVER THE DAM.

in the Desplaines River at Joliet. From Joliet the Illinois & Michigan Canal makes available the Illinois River.

With plenty of funds available for the work, expense has not been spared to secure the best engineering talent and purchase the most modern apparatus.

A dam is formed across the canal by the power-house, controlling works and ship lock, which are placed side by side. Fig. 1 is a view of the power-house from the down-stream side, showing the end of the line, the locks and movable dam. At the time of making this picture 300,000 cubic feet of water per minute was passing over the movable dam. Fig. 2 shows one of the lock gates, which gives a lift of fifty-two feet and is probably one of the deepest locks in the world.

The power-house is 385 feet long, seventy feet wide and forty-seven feet high. The channel retaining walls are forty feet high, and bring the water level very nearly to the top of the building on the receiving side, the turbines being served by a fall of almost thirty-four feet. The turbines are located in chambers at the floor level, and discharge through auxiliary chambers to the tail-race.

For the purpose of regulating the flow of water in the canal the controlling works are equipped with seven metal sluice-gates and a bear-trap dam. The sluice-gates have a vertical play of twenty feet and openings of thirty feet each. The bear-

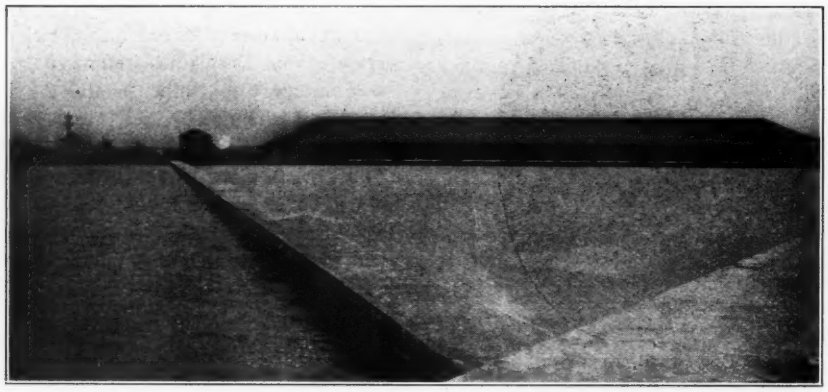


Fig. 3.—View of Power-House, Up-Stream Side, Showing Fender Wall Used to Ward Off Ice and Other Materials Which Would Fill Up the Racks.

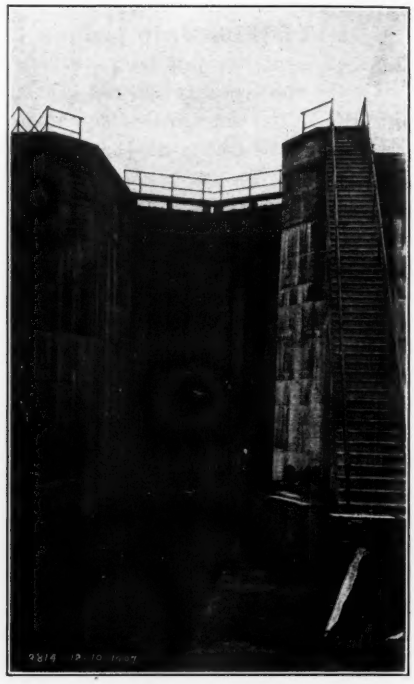


Fig. 2.—View of Lock Gates.

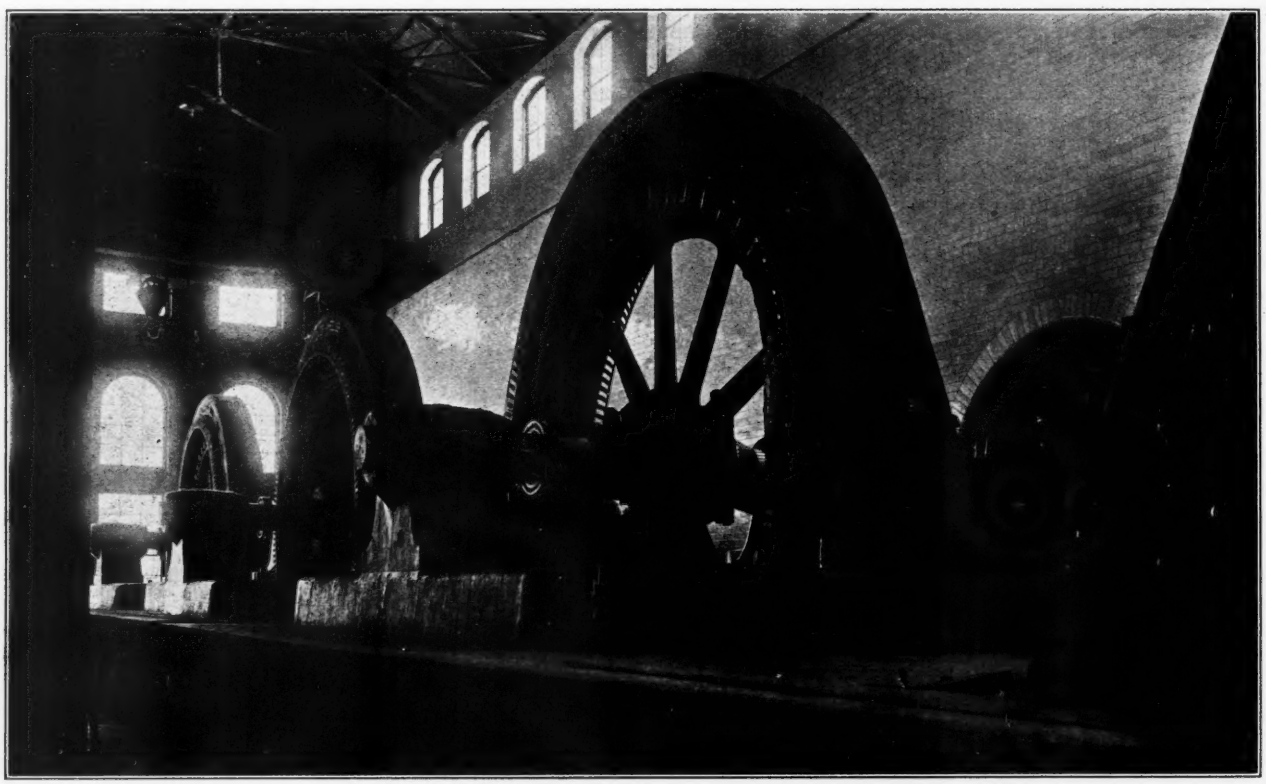


Fig. 4.—Sanitary District of Chicago. View of 4,000-Kilowatt Generators, with Water-Wheels in Adjoining Chambers.

trap dam has an opening of 160 feet and an oscillation of seventeen feet vertically. The controlling works are operated by admitting water through conduits controlled by a valve.

Fig. 3 is a view of the power-house from the up-stream side, showing the fender wall used to ward off ice and other materials which would fill up the racks. The concrete guard or fender protecting the forebay from floating ice and other material is built at an angle across the channel. The arches of this fender are four feet below the surface, and the structure lies directly in front of the wheel pits, diverting to the bear-trap dam discharging below the power-house such ice and debris as might imperil the racks. The wheel chambers proper are protected by ice racks extending the length of the power-house. Debris that might enter the forebay and flow against these racks is passed over a smaller dam, also discharging below the power-house.

The material for the construction of the foundations and the power-house was obtained from the excavation, and the plant is built on solid rock, the various structures being constructed of concrete. No combustible material of any kind was used in the construction of the power-house.

The present installation in the power-house consists of four 4,000-kilowatt, three-phase, sixty-cycle, alternating-current generators, and two 350-kilowatt, direct-current exciter units, built by the Crocker-Wheeler Company, of Ampere, N. J. The four alternators and the two exciter sets are driven by Wellman-Seaver-Morgan Company's horizontal water-wheels, and a fifth alternator for which provision is now being made is to be driven by a horizontal turbine built by the S. Morgan Smith Company, of York, Pa. The power-house is designed for the ultimate installation of eight 4,000-kilowatt generators and three 350-kilowatt exciter units. The horizontal water-wheels driving the alternators are rated at 6,000 horse-power, and the exciter water-wheels are rated at 600 horse-power each.

The 4,000-kilowatt alternators are of rigid construction, with frames of the box type, and employing features which are of particular merit in an installation of this character. The stator laminations are punched with partly closed slots, permitting the use of solid pole shoes. Threaded conductor windings placed in substantial insulating tubes are inserted in the slots. The excellent insulation obtainable with this form of winding makes the rotor windings accessible without shifting the rotor axially. The distance between bearings makes possible a short, rigid shaft. The rotor consists of a solid

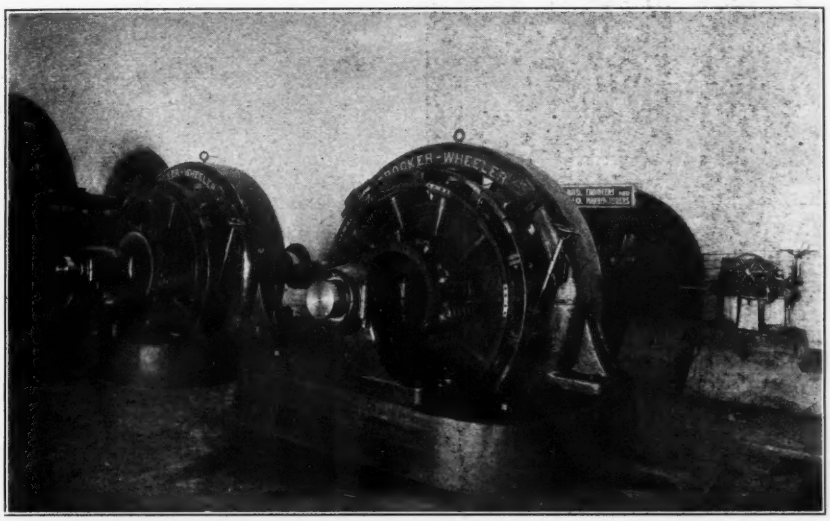


FIG. 5.—SANITARY DISTRICT OF CHICAGO. VIEW OF EXCITER UNITS.

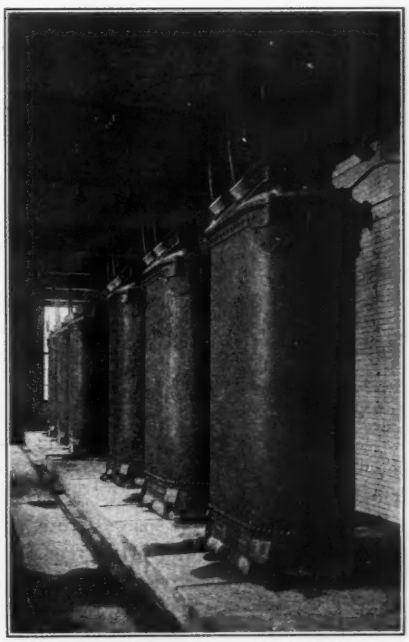


FIG. 6.—VIEW OF TWO OF THE FIVE BANKS OF 1,333-KILOWATT TRANSFORMERS.

FIG. 7.—VIEW OF TRANSFER BOARDS IN POWER-HOUSE.

FIG. 8.—BUS-BAR COMPARTMENTS AND REMOTE CENTRAL RHEOSTATS.

casting split in two parts, firmly bolted together. The poles and pole shoes are securely bolted to the circumference of the rotor. Flat copper conductors, wound on edge, are used for the rotor windings. This insures a radiating surface on every turn of the winding. Uniform temperatures are secured throughout, due to these features and the ventilated type of stator core and housing. Fig. 4 is a view of the alternators, and Fig. 5 a view of the exciter units.

There are five banks of transformers, each bank containing three single-phase oil and water-cooled, 1,333-kilowatt transformers made by the General Electric Company, Schenectady, N. Y. This company also furnished the switchboards, high-tension switches and lightning-arrester equipments. Each transformer is guaranteed to operate safely under an overload of twenty-five per cent. Fig. 6 shows two banks of these transformers.

The generators are arranged along the north side of the power-house, the water-wheel for each machine occupying an adjoining chamber. The space devoted to the generators and water-wheels occupies an area 385 feet by thirty-five feet. This space is served by a forty-ton electric crane. The opposite side of the power-house is occupied by the switchboards, transformers, bus-bars, oil-switches, circuit-breakers, lightning-arrester apparatus and other details of service. The transformers are located directly behind the service boards on the ground floor, and in two galleries above the ground floor are located the main switchboard, field switches, disconnecting switches, oil switches, compensators and transfer bus-bars. On the top floor are located the oil switches, the oil switches for the bus-bars and the 44,000-volt bus-bar compartments.

The general arrangement of the power station is such that a water-wheel generator and three transformers make up an individual unit. This idea is carried out up to the high-tension bus-bars, switching being done on the high-tension side of the transformers. So that the generators and transformer banks may be interchangeable, transfer bus-bars are provided, but these will be used only in the event of it becoming necessary to operate a generator on a bank of transformers which is ordinarily used for another generator. The transfer buses are mounted on transfer boards made up of marble slabs sixty-three inches wide, ninety inches high and two inches thick. These boards are provided with barriers containing three single-pole, single-throw, hook-type switches of 450 amperes' capacity, 6,600 volts. There are also three single-pole, double-throw, hook-type switches of the same capacity, with three connecting bars between the jaws of the single and double-throw switches. Each alternator is connected to its transfer board by two three-phase stranded copper cables of 300,000 circular mils each. Three series transformers are mounted on the top of each transfer panel, and through these the top switches on the board are connected to the primary side of the corresponding bank of main step-up transformers. Fig. 7 shows the transfer boards in the power-house.

From the transformers the high-tension leads are carried through two three-pole oil circuit-breaker switches placed in

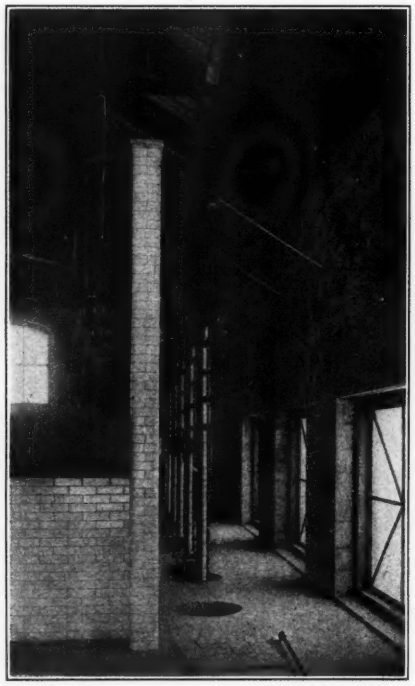


FIG. 9.—VIEW OF LIGHTNING ARRESTERS SHOWING CHOKE-COILS AND CIRCUITS ENTERING BUILDING.

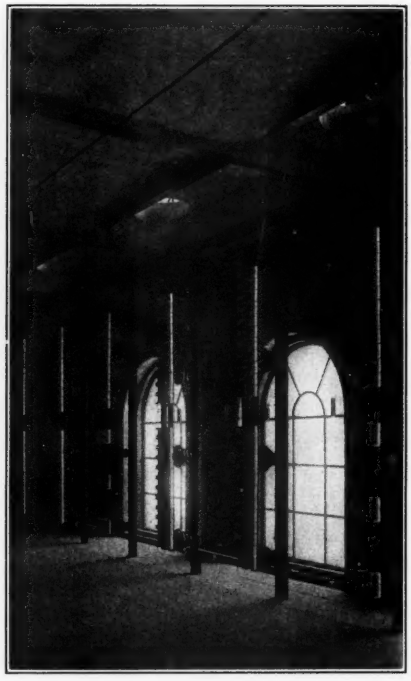


FIG. 10.—ANOTHER VIEW OF THE LIGHTNING ARRESTERS.

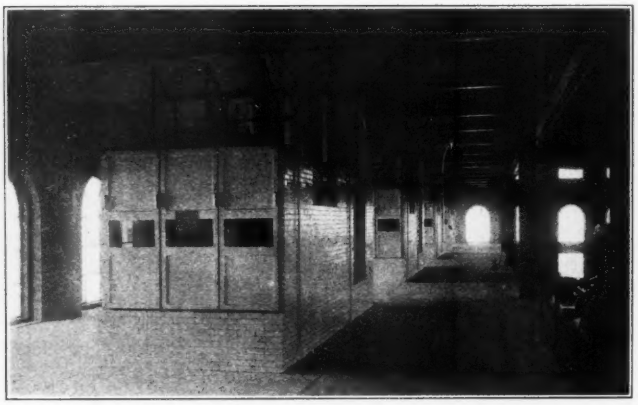


FIG. 11.—VIEW OF REMOTE-CONTROL CIRCUIT-BREAKERS.

FIG. 12.—VIEW OF MAIN SWITCHBOARD, DIRECT-CURRENT BUS-BARS, AND FIELD SWITCH STRUCTURE. BALANCING SET AND SWITCHBOARD.

series. Passing through these switches, which are located, as before mentioned, in the first balcony or gallery, the leads are carried up to the second or top gallery in enameled brick compartments to the high-tension bus-bars. The high-tension bus-bars are also enclosed in brick compartments. These bus-bars extend the entire length of the four units, and the two outgoing circuits are connected through oil circuit-breaker switches provided with time-limit relays. The circuits are carried in enameled brick compartments to the end of the building, where they are provided with lightning arresters at the point where they leave the station.

FIG. 13.—BACK OF MAIN SWITCHBOARD. FRONT VIEW OF EXCITER BUS-BARS. BALANCING SET. FRONT VIEW OF OIL CIRCUIT-BREAKERS.

mounted the alternator field switches. The alternator field rheostats and the exciter rheostats are located on the second gallery, and are also operated by distant-control switches. Fig. 8 shows the bus-bar compartments and remote-control rheostats.

Fig. 9 shows a side view of the lightning arresters with the choke-coils and the circuits entering the building. Fig. 10 shows another view of the lightning arresters. Fig. 11 shows the remote-control circuit-breakers.

In the main control board, which is located on the first gallery, a panel is devoted to each generator and exciter unit. The exciter panels are provided with the usual instruments, and each alternator panel has an ammeter on each phase, a watt indicator, power-factor indicator, ammeter for the fields, synchronizing and voltmeter receptacles. There is also a swinging panel, well shown in Fig. 12, containing two 6,600-volt voltmeters, a frequency indicator and an exciter bus-bar voltmeter. Placed above and in the centre of the main control board is a synchroscope. Directly behind the main control board, in Fig. 12, are seen the direct-current bus-bars, the field switch structure and the balancer set and its switchboard.

The operating panel on the main control board is equipped with push-and-pull-type switches for operating the remote controls, the rheostats and the water-wheel governors. The switches are equipped with lamps to indicate the movement of the apparatus under control. An integrating wattmeter is provided, in addition to the other measuring apparatus, for keeping tally on the output of each generator. Fig. 13 shows a view of the back of the main switchboard, a front view of the exciter bus-bars, the balancing set and a front view of the oil circuit-breakers.

Current is transmitted from the power-house over two three-wire aluminum circuits twenty-nine miles long. The three-phase circuit is arranged in delta, one circuit being placed on each side of a sixty-foot steel mast. The transmission potential is 44,000 volts, and a ground wire is carried on the apex of the poles. The poles are made of steel, of bridge construction, forty-two inches at the base and twenty inches at the top, each weighing 4,000 pounds. The cross-arms are of bridge construction, the lower arm being eighteen feet long and weighing 600 pounds, and the top arm is twelve feet long, weighing 300 pounds. These masts were built by the Aermotor Company. The poles are placed 350 feet apart, and are set in the ground six feet, the hole surrounding the pole feet being filled up with concrete, which is banked for six inches above the surrounding earth and rounded off so that there will be no lodg-

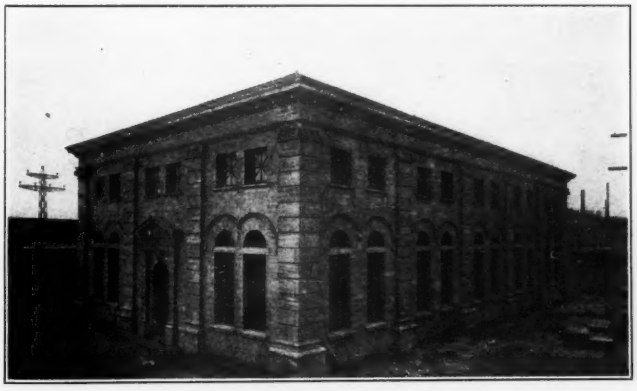


FIG. 14.—SUBSTATION AT WESTERN AVENUE. PRESENT CAPACITY 20,000 KILOWATTS.

FIG. 15.—WAREHOUSE AT THIRTY-FIRST STREET AND WESTERN AVENUE, SHOWING END OF LINE.

The connections to the bus-bars for the exciters are made through automatic circuit-breakers and remote-control switches. The exciter bus-bars are placed in white enameled brick compartments, the bus-bar structure carrying the switches. From the exciter bus-bars the leads are carried to a similar structure, upon which are

ment of water about the base of the pole. The transmission wires are carried forty-seven feet above the ground, on Locke insulators fourteen inches in diameter and twelve inches high.

The transmission line terminates in a substation at Western avenue and the Drainage Canal, a view of which is shown in Fig. 14. A good view of the transmission line towers is given in Fig. 15, at the end of the line. Each line terminates in a set of bus-bars, the step-down transformers being connected to these bus-bars through oil circuit-breaker switches. The transformers may be operated in parallel by means of an oil switch between the two sets of bus-bars. Secondary current passes through oil switches to a set of low-tension bus-bars arranged the same as the primary side for parallel operation. From the low-tension bus-bars the distributing circuits pass through oil switches to the various points of distribution, each circuit being equipped with a total-watt indicator, power-factor indicator and integrating wattmeter.

The substation control board duplicates the arrangement in the power station. There is also a motor-generator unit which supplies direct current for operating the switches and lighting the building; and a 1,000-ampere-hour storage battery is in readiness for any emergency. Cooling water for the transformers is supplied by motor-driven centrifugal pumps. The present capacity of the substation is 20,000 kilowatts. The structure is built of concrete, and its main dimensions are 124 feet long, seventy feet wide and forty-two feet high.

The power which will be available from this plant will be distributed to enterprises located in the surrounding neighborhood. Chief among those to whom the power will be supplied will be the city of Chicago. At the four stations in the city of Chicago where steam-driven apparatus is now used, arrangements are being made to install synchronous motors, which will be connected to the generating machinery. It is understood that a uniform price of $15 per horse-power-year will be received for this power.

The Sanitary District of Chicago is a public body organized under the laws of the state of Illinois, and is controlled by its officers and board of trustees. The president is Robert R. McCormick; the treasurer, Charles L. Hutchinson, and George M. Wisner is chief engineer.

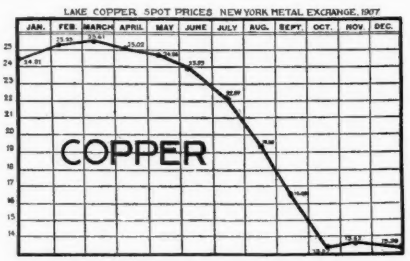
The electrical installation has been carried out under the supervision of Edward B. Ellicott, who is one of the most prominently known electrical engineers in the West. Mr. Ellicott has long been identified with responsible positions, and is probably best known for his work as city electrician of Chicago and chief electrician and mechanical engineer of the St. Louis Exposition. The power station is in charge of W. C. Robinson.

Conditions of the Copper Industry.

The copper industry is closely related to the electrical industries, since the latter are the main consumers of copper, and activity in electrical fields means an active demand for copper and, usually, high prices. On the other hand, the price of copper depends also upon the supply. This factor was prominent in the remarkable changes in the price of copper which took place in the year just closed. An instructive review of the conditions was given by Senator William A. Clark, in the "Annual Financial Review" of the New York *Times*. In this Mr. Clark points out the great increase in the demand for copper during the past ten years, due to expanse of all the electrical industries. Two or three years ago the supply was not equal to the demand, copper became scarce, and the price advanced rapidly until it reached twenty-six cents a pound. These high prices led to the opening of new mines that could not be worked profitably at the low prices prevailing a few years previously. The result was that production outstripped consumption and copper began to accumulate.

Last summer when the reaction in the business world began those holding these stocks of copper put them upon the market and prices started to go down. The decline started in July and was rapid until in October it had dropped to twelve cents a pound, less than fifty per cent of its selling price a few months before. This price was much below the cost of production at many mines, and they were forced to close down. Indeed the price offered but little profit if any to the larger companies and the owners of the richest mines. The result of this was that the great companies also began to restrict their production, running down the output from twenty to sixty-five per cent. On this account 200,000,000 pounds of the copper which had accumulated have been absorbed, and the remainder of the surplus will probably be entirely used up within the next three or four months. It is probable that the price will then begin to advance again, but it is hardly likely that it will reach the high price prevailing early last year. At fifteen or sixteen cents a pound many of the mines which produced at the higher prices will be unable to resume, so that there will not be the same tendency to overproduction and the price will probably not vary so greatly as it did. One result of a decrease in price has been the throwing of thousands of hands out of work. Senator Clark says that he himself knows of nearly one hundred of the smaller mines that have shut down, and even the larger ones have greatly decreased their operating forces.

The same issue of the *Times* contains a short discussion of the copper production during the year just closed by Hermann A. Keller. During the year 895,104,000 pounds of copper were produced, as compared with 917,620,000 the previous year. Last year Canada produced 44,546,000 pounds, and Mexico, 126,710,000 pounds. These two countries produced in 1906 42,121,000 and 135,800,000 respectively. Thus it would seem the total production for the North American continent during the year 1907 was 1,066,360,000 pounds of copper. Of this the largest production was in Arizona, this being over 260,000,000 pounds. Michigan followed next with 234,000,000, and Montana with 227,000,000. During 1906 Montana produced nearly 300,000,000 pounds of copper, and the decrease in



RANGE OF SPOT PRICES FOR COPPER DURING 1907.

production in that state during the year was one of the most notable changes. There has been an increase in every other state with the exception of Arizona, where the decrease was 3,000,000 pounds. The accompanying diagram shows strikingly the range in the price of copper during the year.

Mr. Keller says that the present rate of production is only about seventy per cent of the normal, and this is coupled with a steadily improving business outlook and the fact that the manufacturers now carry almost no stocks and there is a brisk European demand for the metal. Under these conditions it may be expected that the price of copper will be about fifteen cents a pound or a little higher, subject, of course, to temporary fluctuations. This is a healthy figure, which would leave a fair margin to all large producers, especially when running full capacity. In connection with the above it is interesting to note the announcement of the United Metals Company of an advance of one-quarter cent on electrolytic copper on January 29.

HIGH-VOLTAGE INSULATOR MANUFACTURE.[1]

BY WALTER T. GODDARD.

PORCELAIN INSULATORS.

The transmission of power by means of electric currents of greater or less voltage began with the introduction of the electric telegraph, and almost the first problem encountered was line insulation. It is of interest in this discussion to note that the first insulators successfully used were of porcelain. From that time to the present the progress has been rapid, the voltage having risen from the two or three volts of the telegraph to a present prospective line voltage of 150,000, and from the lowest to the highest it has always been recognized that best construction involved the use of porcelain insulators.

Fig. 6 shows sectional drawing of a high-tension insulator made of several shells nested together and arranged to be fastened together by means of thin joints of Portland cement. This is the conventional design and is used for all voltages, though the size, number of shells, and shape may vary with the voltage. In general, American high-voltage insulators are now made of several shells nested together, while European manufacturers still persist in turning complicated shapes from solid masses of dry clay.

The manufacture of porcelain is one of the oldest arts, but only recently has it in any sense been placed upon a scientific basis; in fact, potteries for the production of electrical porcelain exclusively have not been in existence for more than ten years, and during that time it has been necessary to develop an entirely new system of handling pottery products.

Porcelain for electrical purposes is a mixture of ground flint or silicon dioxide and feldspar, or ($K_2O\ Al_2O_3SiO_2$) potassium aluminum silicate, raised to vitrifying temperature, that is, to a temperature sufficiently high to melt the feldspar and permit it to unite the particles of flint into a perfectly homogeneous body of uniform electrical and mechanical strength. The production of electrical porcelain differs from the ordinary pottery product in that, in addition to presenting a symmetrical and flawless exterior, it must possess inherent electrical and mechanical strength.

FIG. 1.—PLASTER MODEL OF 60,000-VOLT INSULATOR TOP.

PROCESS.

Flint and feldspar occur in Nature as rock which is reduced at the mine by grinding to a degree of fineness comparable to that of flour and of equal whiteness. The modern electrical porcelain potter mixes the proper proportions of flint and feldspar and again grinds the material in the presence of water in order to obtain intimate mixture. The mixture, or, as it is dubbed in the factory, "clay," is separated from the excess water, immediately after leaving the grinding mills, by means of filter presses and afterward brought to uniform plasticity by means of kneading machinery.

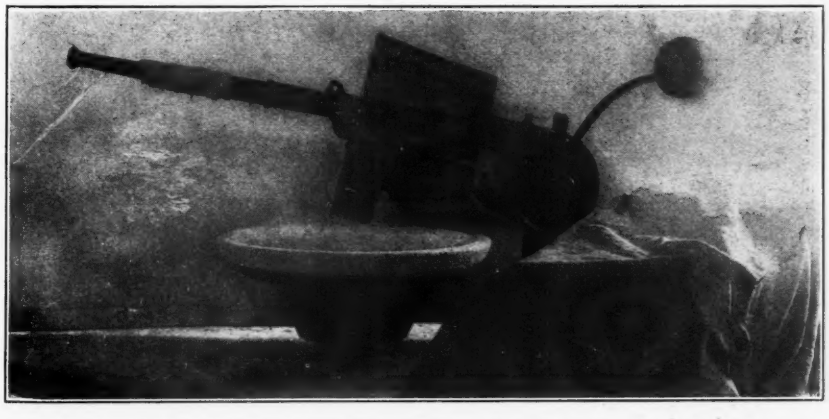


FIG. 2.—CONVENTIONAL POWER-DRIVEN POTTER'S WHEEL AND FORMING TOOL.

The first step in the construction of an insulator is to build a model sixteen per cent larger than the required insulator, and from this model to make molds of plaster of Paris. Fig. 1 shows a plaster model of a 60,000-volt insulator top from which the mold in Fig. 2 was taken. Each shell of a multipart insulator is treated in this manner, the inside contour of the mold being that of the desired shell. Fig. 2 shows a conventional power-driven potter's wheel upon the top of which is fixed the mold partly filled with clay. The whole device is rotated rapidly and a forming tool whose profile is that of the inside shape of the shell under consideration, is forced into the mass of clay. A few revolutions usually accomplish the desired end and the mold with its wet and plastic clay is then placed in a hot room of approximately 130 degrees Fahrenheit. Within an hour the warm air and plaster mold have absorbed a large proportion of the water in the clay, and the embryo insulator may be removed from its mold and the rough surface, which originally rested against the mold, scraped smooth. The shell, as it may now properly be designated, is set aside for a period of ten days to two weeks in order that all water held by the clay be evaporated. If fired in this state the shell would come from the kiln hard, white and quite rough, of good dielectric strength, but with a surface which would gather and hold dirt and soot and, because of the extreme fineness of the irregularities, be practically beyond possibility of cleaning. For this reason, and no other, are the insulators covered with a glassy coating of extreme smoothness, capable of being washed by the gentlest rains. The glazing process is very simple. Immediately before being placed in the kiln, the insulator shell, which in its dry state is about as strong as blackboard crayon, is dipped into a solution of clay and water and by virtue of its dryness absorbs a certain amount. On being heated the clay melts before the body vitrifies and so spreads very evenly over the entire surface. The presence of a small amount of iron in the clay is responsible for the brown color so generally used in this country although any color can be obtained by the use of the proper materials in the glaze. The firing process is entirely a matter of temperature and its complications are all practical ones due to the large amount of material burned at one time and the difficulty of obtaining exact and uniform heat throughout the kiln.

MECHANICAL AND ELECTRICAL TESTING.

The mechanical properties of porcelain are so unvarying that a sample test has al-

[1] A paper read before the Electrical Section of the Canadian Society of Civil Engineers, December 19, 1907.

ways been deemed sufficient. On the contrary it is considered unsafe to permit any porcelain to go into service without testing each piece by means of a high-voltage transformer. As will be explained later the higher voltage insulators are made up of several shells each of which is subject to a high-voltage test of 50,000 to 60,000 volts. Fig. 3 shows the connections between the high-voltage transformer and insulator shells to be tested. Fig. 4 shows this method as practised. The table is insulated from the floor by means of porcelain cones in order that high voltage may be applied to the wire imbedded in the table top and designed to make contact with the pans arranged for the reception of porcelain shells. The pans are filled with water and so form one terminal of the high voltage. The other terminal is formed by water poured into the shell, attachment between it and the high-voltage overhead conductor being made by means of small chains. By some controlling device in the low-voltage side of the transformer the voltage applied to the shells of porcelain is kept very near to arcing over, in most cases being about 55,000 volts. For ordinary commercial testing the spark-gap in air is usually employed when it is desired to ascertain the applied voltage. The number of failures is usually two per cent or three per cent of the number tested. When porcelain fails electrically the short, powerful power arc through the very small puncture hole amounts to practically a short-circuit upon the testing transformer and the excessive heat liberated in the porcelain often boils the water and destroys the shell. Once punctured the porcelain is ruined and can by no method at present developed be recovered.

The parts of multipart insulators are united by means of pure Portland cement mixed with water only. After the cement has obtained initial set the insulators are subjected to an assembled electrical test of double line potential for a period of time sufficient to remove all doubt as to the electrical strength of the insulators, usually from three to five minutes. To facilitate cementing and testing, racks, as shown in Fig. 5, are provided so that the operations may be performed with a minimum of handling. There is one very marked advantage in this manner of applying the assembled test voltage, and it is that the voltage may be put on before the cement is dry enough to permit handling of insulators so in case of failure by puncture of any shell, it may be separated from the others without injury, a thing absolutely impossible once the cement becomes dry.

DESIGN OF HIGH-VOLTAGE INSULATORS.

Insulators for the lower voltages call merely for the introduction of sufficient good material, between line and supporting structure, to prevent destructive leakage. For voltages up to 20,000, little or no difficulty is experienced in securing satisfactory insulation, but above that voltage it becomes not only necessary to have good material in plenty, but it must be properly distributed in order that the danger of puncture and severe leakage be reduced to a minimum. The manufacture of good porcelain from a mechanical standpoint forbids that it be made so vitreous as to resist a puncture test of 65,000 to 70,000 volts over one-half-inch or five-eighths-inch thickness. It is vain to attempt to gain greater dielectric strength by increasing thickness since inherent cracks in thick pieces really reduce the effective electrical strength to that of one-half-inch or five-eighths-inch porcelain. Accordingly, it has come to be recognized as best practice to make no attempt to manufacture the higher voltage insulators in a single piece, but rather to secure great electrical strength by multiplicity of parts. Though entirely possible to construct 30,000-volt insulators of one piece and still safely apply a double-potential test, years of experience have demonstrated that a multipart insulator is much less liable to fail entirely, when struck by stones or bullets, than are single-piece insulators and so prevent complete shut-down of the transmission line. By far the larger proportion of shut-downs on the modern transmission line come from mischievously broken insulators. It is for this reason as well as for greater normal safety factor that engineers are selecting multipart insulators at higher cost, even for the lower voltages. In general, two-piece insulators are used for from 10,000 to 30,000 volts; three-piece for from 30,-

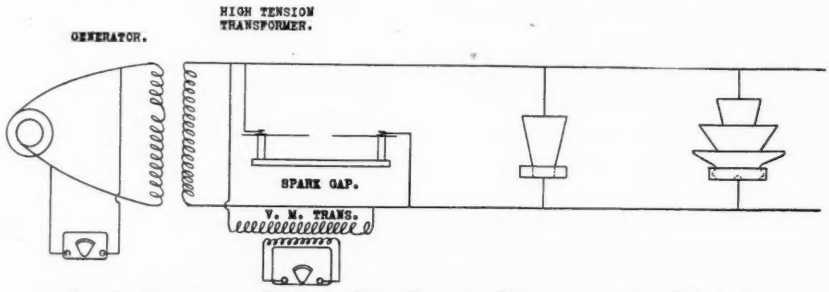


FIG. 3.—CONNECTION BETWEEN HIGH-VOLTAGE TRANSFORMER AND INSULATOR SHELLS TO BE TESTED.

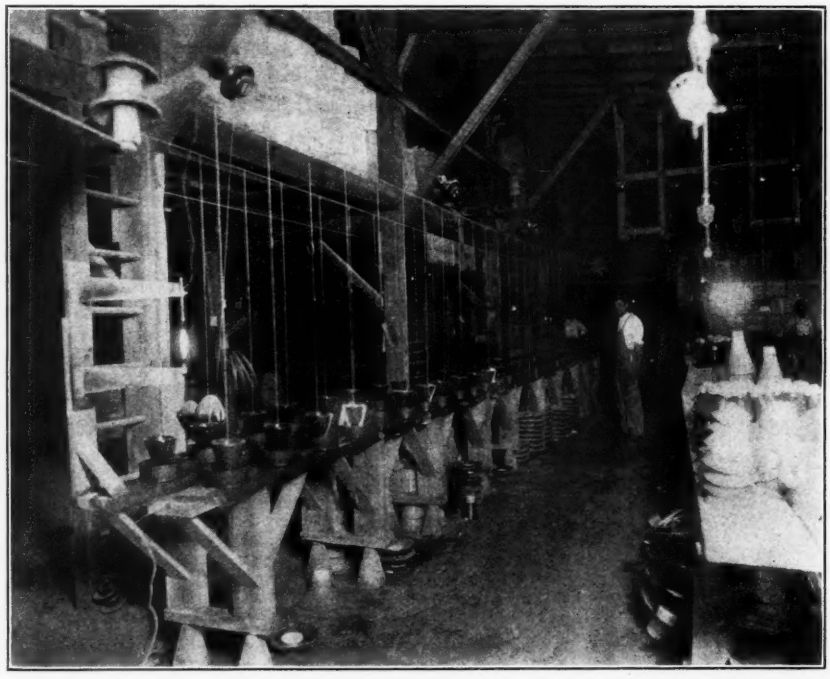


FIG. 4.—METHOD OF TESTING INSULATOR SHELLS.

000 to 50,000 and four-piece for the 66,000 and 70,000-volt lines now in operation. Above 70,000 volts the underhung or suspended insulator works out most economically and, for entirely different reasons, eight or ten shells of porcelain are introduced.

Considerations of puncture strength are the first concern of the designer. As before noted, good electrical and mechanical porcelain should be made of not more than five-eighths-inch thickness with an ultimate electrical strength of not more than 70,000 volts. To gain greater electrical strength it is necessary to introduce other shells which continue to add a proportional dielectric strength up to about

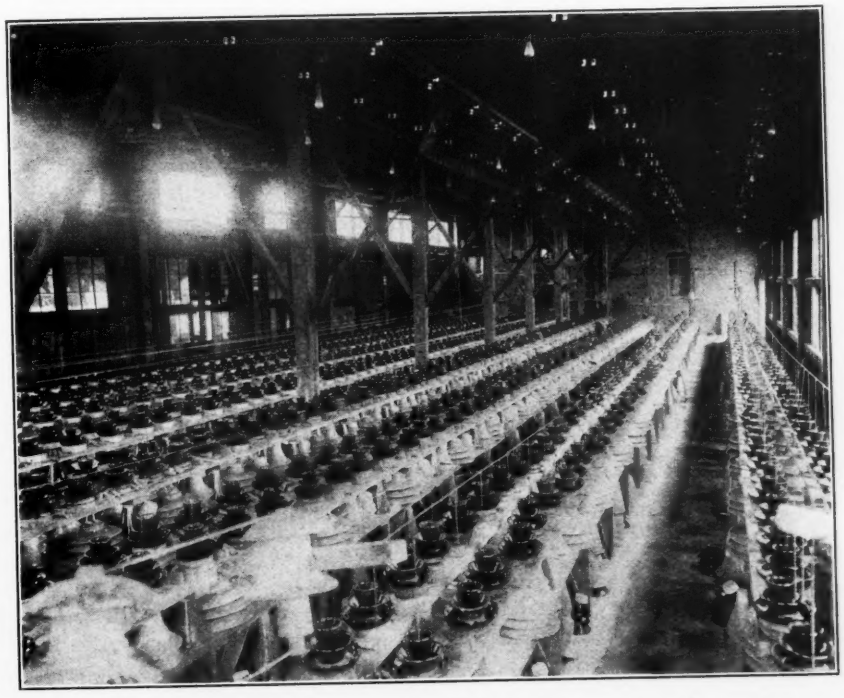


Fig. 5.—Testing Insulators while in Process of Cementing and Assembling.

220,000 volts, at which point the curve gradually tends to become flat and becomes very nearly so at 300,000 volts, so that it is apparently useless to utilize more than five shells unless some other condition is introduced. With this to start with it is a very simple matter indeed to provide economical insulators for any voltage up to the point where difficulty of manufacture begins to interfere with progress. The 10,000 and 20,000-volt insulators have little to do with puncture strength provided, of course, that the porcelain is of good quality, and so the question reduces to an estimate of necessary leakage distance and carrying capacity when subjected to an artificial rain approximating the worst conditions to which the insulator will be subjected. This is not so simple as appears on the surface, for while an insulator may behave admirably under a downpour of unprecedented intensity, it is vain to expect Nature to limit herself to a vertical, or what is technically known as a forty-five-degree rain, nor does she stop after five, ten or fifteen minutes, but is much more likely to accompany the downpour with sufficient wind to blow the rain very nearly horizontally, and to persist for any length of time. Under such conditions the insulator either meets its Waterloo or shows its mettle in the first fifteen minutes, for at the end of that time all portions, except possibly the inside of the innermost shell, have become thoroughly wet and the surface leakage comes into play. As is well known, the persistence of any arc of definite length has to do with the voltage impressed and the current flowing, and the failure of an insulator is, of course, amenable to the laws which govern arcs. A designer should assume that his insulator will sometimes become wet all over and should provide sufficient leakage resistance to prevent any considerable amount of current flowing, a small amount merely tending to dry off the insulator whereas a large amount would quite likely start a disastrous arc under the shells and completely destroy them by its heat before extinguishing itself. Such an insulator represents very nearly the ideal and it is regrettable that so few lines are equipped with insulators of so great a margin of safety. It must not be forgotten that only once or twice a year are insulators called upon to perform extreme duty, in fact, the insulators of most lines are for the greater part of the time working very inefficiently, probably at not over twenty per cent of their rated capacity.

The next best thing is to provide as much dry surface as possible under average storm conditions and to this end it is of value to note the progressive wetting of an insulator under rain. It is customary to mount the insulator well above the cross-arm so that all its shells are far removed from water spattering up from the arm. Assume an insulator of conventional design of three or four shells: The top becomes dripping wet at once and the film of water held on the surface carries line potential to the outmost diameter. A certain amount of rain gets by the top and strikes upon the lower shells, part spattering upward and part downward, depending upon the angularity of precipitation. That portion which spatters upward soon wets the entire under surface of the shells above and in this manner the potential is carried down to the lowest projecting shell. At this point the leakage path is broken, due to the fact that beneath the lowest shell there is no surface from which spattering may occur and consequently it remains dry, but under this condition the central shell of the insulator is carrying the total strain both as to puncture strain and against flash over. Fig. 6 shows clearly the effect of spattering, the double line indicating the surfaces covered by a film of water and thus carrying line potential down to the bottom of the lowest projecting shell. It may be further noted that between this double line, or line potential and the pin, there is but one effective shell which has been subjected to but 60,000-volt test, and lines of very moderate potentials have strains of this magnitude between line and earth. The shells must, of course, remain wet till the storm is over or some drying action is introduced. If the gap between the edge of the lowest shell and the pin is small enough a small arc will be established, thus completing the circuit and permitting a leakage current, formerly held in check by the dry inner surface of the shell, to flow, though limited in volume by the relatively high resistance of the pure water film covering the insulator. This leakage current heats and vaporizes the water film, its first action naturally being where the current density is greatest—

at the neck of each shell, where, fortunately, the surface is not subject to the direct force of the rain. Since potential is in no way concerned with resistance, the thinnest and consequently highest resistance film of water is sufficient to inaugurate the drying process, so that an insulator in service can not be caught unawares and, if properly shaped, can care for itself.

From the foregoing it will be seen that the dielectric strength of the inner shell of any multipart insulator and the distance between its lowest edge and the supporting pin are of utmost importance, the remainder of the insulator serving as little more than a resistance in series or leakage distance to limit the amount of current which may flow when arcing takes place. To provide against the first requisite it is merely necessary to introduce a protected shell which can not easily become wet. This is shown in Fig. 7, as is also

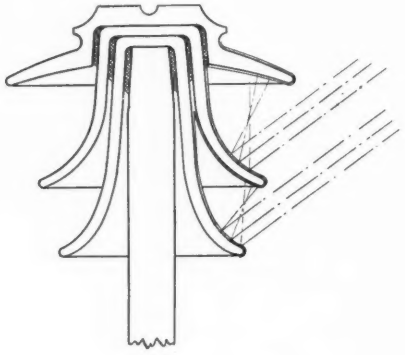


Fig. 6.—Sectional Drawing of High-Tension Insulator.

the great distance between pin and edge of lowest shell. What has been said applies to insulators as it is necessary to build them to meet mechanical conditions imposed, and it is the mechanical characteristics, not the electrical, which influence their cost. Were it possible to make porcelain ware of great strength, an insulator of perfect certainty of action could be produced at minimum cost. An insulator should not be regarded as a barrier to current, but rather as a high-resistance path between line and earth, and its design should aim to serve this purpose. Referring again to Figs. 6 and 7 it will be seen that as far as the ultimate strength of the insulator is concerned, the shape of the upper shells is of no moment, since they serve as series resistance only. There are reasons, however, why straight shells should be used and others equally good why curved shells should be introduced, but the adjustment between the desirable points of one and the desirable points of the other call for fine discrimination. Figs. 6 and 8 show straight and curved shell insulators subjected to a forty-five-degree storm which spatters most vigorously in the direction shown by the arrows. Of these two insulators the straight shell would probably keep dry the longer, since a large portion of the falling water is deflected. On the other hand, the distances A-B, C-D and E-F are much greater on the curved-shell type, permitting it to carry much greater potential previous to its becoming wet all over than could the insulator of the straight shells. The curved shells will thus be better able to take care of sudden potential rises when partly wet than will those of the straight-shell form. However, this partly wet con-

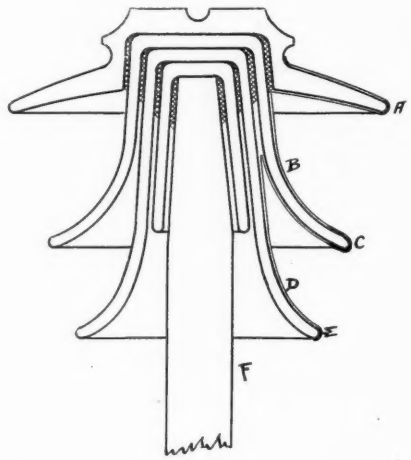


Fig. 7.—A Protected Shell which Can Not Easily Become Wet.

dition does not last long, as there is often abundant enough precipitation to entirely wet the shells, and it is only then that the insulator can be assumed to be operating under full load, a condition for which it should be designed.

The foregoing applies equally well to low-voltage insulators, though up to 40,000 volts it is hardly necessary to provide protection for the innermost exposed shell since its own strength is entirely ample.

So much space has been given to discussing the value of the insulator when under rain that its pleasant-weather qualities may seem to have been overlooked, but there are sudden and severe demands upon the insulator in the pleasantest weather mainly from lightning and switching. When a rise of potential far above normal working voltage comes upon a perfectly dry insulator, the stress between line wire and pin is very sensibly increased, and that this stress shall not be too severe the distance between line wire and pin should be made ample by the introduction of several shells of porcelain. The specific inductive capacity of porcelain, or its flux-carrying capacity, is a perfectly definite thing, compared to air about 4.4, so that for any given potential, area of contact and thickness of shell, the density is determined.

Porcelain, however, unlike some dielectrics, gives due notice when overburdened, by a pale violet light over its entire surface. Fig. 9 shows two porcelain shells subjected to 100,000 volts, their very evident distress being photographed by their own light. Fig. 10 shows better than can words how it is that so many lines have trouble with central shells breaking down. The designers in this case had failed to provide against the great concentration which will in time disrupt the finest porcelain. Fig. 11 shows one of the largest insulators ever built, being tested at 175,-

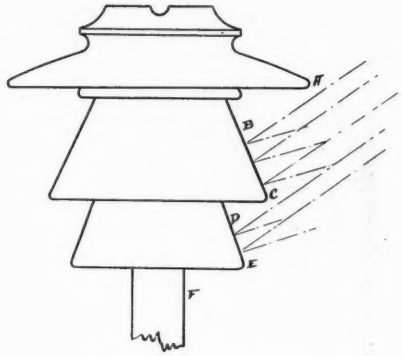


Fig. 8.—Straight Shell Insulator.

000 volts, its distress being very evident and presaging early break-down. How very little it takes to correct this fault is easily seen by a moment's contemplation of the fact that the stress within the porcelain will vary inversely as the square of the distance between terminals. From these experiments it appears that to avoid getting into serious trouble when potentials somewhere near the arcing over capacity of the insulators are applied, it is necessary to provide considerable body of insulating material between line and pin.

Mechanically, insulators can be designed for any load by the proper disposition of material. Good electrical porcelain has a crushing strength in excess of 15,000 pounds, and tensile strength ranging between 1,500 and 2,000 pounds per square inch.

The latest development in excessively high-voltage insulators is but a reversion to a type long since discarded by lower-voltage engineers, *i. e.*, the underhung or

suspended type of insulator. Reference to old telegraph manuals shows that the first English telegraph systems were insulated by underhung insulators of bowl-shaped porcelain. To come down to the present, all our trolley wires are suspended below the supporting device. For years wireless telegraph companies have been using strain insulators in series, so the newest high-voltage insulator is, in reality, the oldest. Fig. 12 shows a modern development of the underhung insulator of five units designed to operate at 100,000 volts, grounded neutral, with a factor of safety of four. It is intended to allow the conductor to swing freely in any direction.

The reason for using suspended insulators is largely a matter of cost since it is entirely possible to build porcelain insulators of the conventional type of sufficient size to successfully operate at any voltage, but the extreme height and diameter of a pin-type insulator for 100,000 or 150,000 volts makes the cost prohibitive. A suspended type of insulator has several advantages which it is well to understand before going into details of design. Of paramount importance is the unit formation making it possible to increase the effective insulation whenever it is desired to raise the line voltage or wherever it seems desirable to present extra leakage surface because of salt fogs or smoke from railways and factories. Many lines start operation at much lower potential than designed for, because the initial load is light and the potential need be increased only when regulation demands it. With the pin type of insulator there is no alternative but to invest at the start in the largest insulators which the line will ever need, whereas in the suspended form, additional units may be introduced whenever the growth of power business warrants an increase in potential. In the pin type of insulator the nearness of line wire and pin must always prove a weak point for lightning assault as well as an aggravator of line-charging current difficulties. The suspended type gets away from both difficulties by a wide separation of line conductor and supporting structure. Incidentally the position of the conductor below the cross-arm permits the supporting structure to act as a lightning rod and so to relieve the line of much lightning stress.

Mechanically, provision must be made to prevent the swinging conductor from coming too near the tower structure, but the extra length of cross-arm necessitated by this feature is more than compensated for in cost by the fact that there are no twisting strains upon the arm.

Insulator unit formation presents another very positive advantage in the matter of breakage. When a shell of a pin-type insulator becomes cracked or broken the whole device is rendered worthless as it is utterly impossible to break the cement joint forming the bond between shells. Further, the cracking of a shell, especially an inner shell, may cause immediate shut-down or at least shut-down during the first severe rain storm. On the contrary, the breaking or cracking of one of the shells of a suspended-unit-type insulator takes away but that one unit from the series; thus, in the case of a five-unit, 100,000-volt insulator, a broken unit reduces the total strength but twenty per cent.

FIG. 9.—TWO PORCELAIN SHELLS SUBJECTED TO 100,000 VOLTS. PHOTOGRAPHED BY THEIR OWN LIGHT.

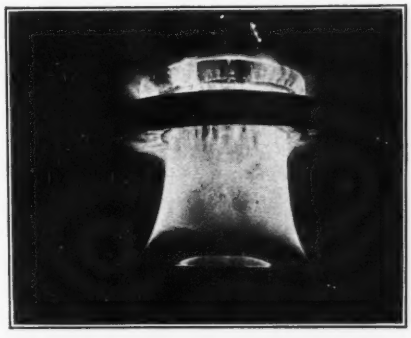


FIG. 10.—BREAK-DOWN OF CENTRAL SHELL.

FIG. 11.—ONE OF THE LARGEST INSULATORS EVER BUILT, IN DISTRESS AT 175,000 VOLTS.

With these very evident advantages it is small wonder that with voltages reaching toward 100,000, the underhung insulator should be adopted. The first question, that of mechanical strength, was promptly disposed of by so designing porcelain parts that strains were all compression. The next question, that of electrical strength under normal operating conditions, was not so easily solved. In the first designs single shells of porcelain of five-eighths-inch thickness were used, but when a series of five such shells was subjected to a 300,000-volt test, a new condition was found to have been introduced in the way of a potential rise around the first units, and it was found by repeated tests that any sudden application of potential, or even change in potential already applied, would puncture the end shells, which, if made of economical pottery size, *i. e.*, fourteen-inch diameter, would have a flash-over potential of approximately the ultimate puncture strength. This condition analyses somewhat as follows: The shells and metallic connecting links form a condenser of certain definite capacity, which for the sake of analogy may be likened to a mass of rubber or other elastic material. Carrying out the analogy, the rubber is struck a smart blow with a hammer. The surface struck, and layers of material immediately adjacent to it, feel the force of the blow most severely, and if the mass be thick and of great inertia, the force of the blow is barely perceptible on the surface opposite to that where the blow was struck. Moreover, the elastic material is no sooner struck and compressed than it attempts to return to its normal shape. This property of inertia is duplicated in the action of condensers in series. Call it what you wish, dielectric hysteresis or anything else, the effect is there, and if proper precautions are not taken the outer layer of resisting medium, in this case a porcelain shell, will be disrupted. Unquestionably the dielectric strength of the unit must be in-

creased, and the proper method is by supplying an inner protecting shell so that the puncture strength of the built-up unit shall be far in excess of its flash-over potential. A unit so constructed is prac-

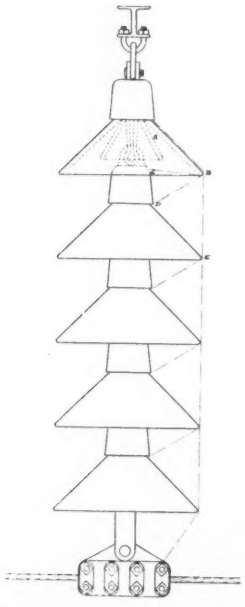


FIG. 12.—SHOWING THE PROGRESSIVE BREAKING DOWN BETWEEN THE BEGINNING OF ACTUAL LEAKAGE AND THE MAXIMUM ARC.

tically indestructible, and will carry continuously its flash-over potential without heating or its surface being covered with static, which impairs the efficiency by shortening the leakage path. Under normal operating conditions the end unit is the only one which is subject to unusual strains, but the failure either by mechanical breakage or arcing over, may at any time put similar strain upon other units, so it is a wise provision to guard all

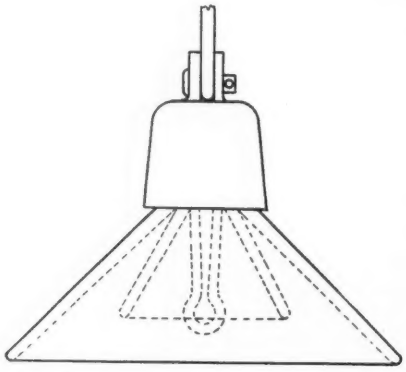


FIG. 13.—CONSTRUCTION OF A UNIT OF A MODERN 100,000-VOLT INSULATOR.

shells against possible puncture. Having made the unit secure against puncture, the next concern is with leakage distance, which must be made of sufficient length to prevent any considerable current flow when the entire surface is covered with a thin film of water. Here again, cost governs, since the unit construction permits the use of a few large or several small parts. As noted before, fourteen-inch is an economical size for the potter to produce, and as the metal parts are the same for any diameter of shell, it is this size which returns most in insulation for each dollar invested. Fig. 13 shows the construction of a unit of a modern 100,000-volt insulator. The shape of the shells is not of importance since in testing to flash-over under working conditions, pains were taken to wet all surfaces thoroughly and so produce artificially the worst possible conditions; but it must not be taken for granted that leakage over an insulator is

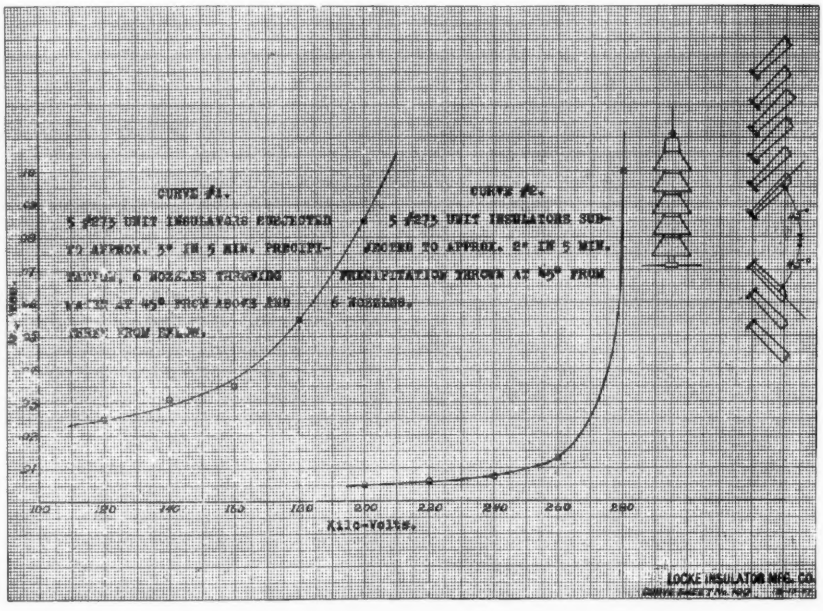


FIG. 14.—CURVES SHOWING ACTION OF A FIVE-UNIT INSULATOR UNDER PARTIALLY WET AND WHOLLY WET CONDITIONS.

a desirable thing, in fact, the time when an insulator will leak sufficiently to dry itself should be postponed as long as possible by logical designing. To accomplish this it is, of course, necessary to permit as little water as possible to spatter on the under side of the shells, and this is best effected by deflecting the water away rather than toward the insulator. If this were the only thing to consider, the best shape of shell would still be in question. There are, however, other conditions. When, in the course of a severe storm the under as well as the upper shell surfaces have become thoroughly wet and leakage has commenced, the first spot to become dry is the inside of the innermost shell at the point of smallest cross-section, A, in Fig. 12, and a small arc is at once formed which, if allowed to persist, will heat and crack the shell. To avoid this the edge of the shell is brought down till the point, B, is of such a distance as to induce the arc to play between B and the malleable-iron cap, C, of the unit immediately below.

An arc of considerable magnitude may be maintained between these two points without heating the shells above sufficiently to cause cracking, since the air currents established tend to keep down the temperature. Current sufficient to support an arc between B and C will, unless the rain be very heavy indeed, dry a portion of the surface between D and E which causes the arc to straighten out, and if there be sufficient current at high voltage, it will eventually be held between the conductor and the supporting structure. Fig. 12 shows the progressive breaking down between the beginning of actual leakage and the maximum arc, which is not sufficiently close to the insulator to damage it. With only 500 kilowatts at 300,000 volts available, the above deductions were found to be true and the ability of the design to rid itself of arcs formed upon it demonstrated beyond question. The suspended insulator thus becomes an automatic relief valve which may be relied upon to discharge the line safely and effectively without damage to itself or serious interruptions to the service.

The curves of Fig. 14 show action of a five-unit insulator under partially wet and wholly wet conditions, and permit of esti-

mate as to probable operating safety factor. The current values which were used in plotting these curves were obtained by means of a Thompson voltmeter, calibrated in amperes, introduced into the high-voltage winding at its middle point. One side of the instrument was well earthed in order to protect the operator. Voltages were gotten by means of a needle gap carefully protected from air currents.

The method of utilization of freely suspended insulators may be of interest. Figs. 15 and 16 show in detail how this

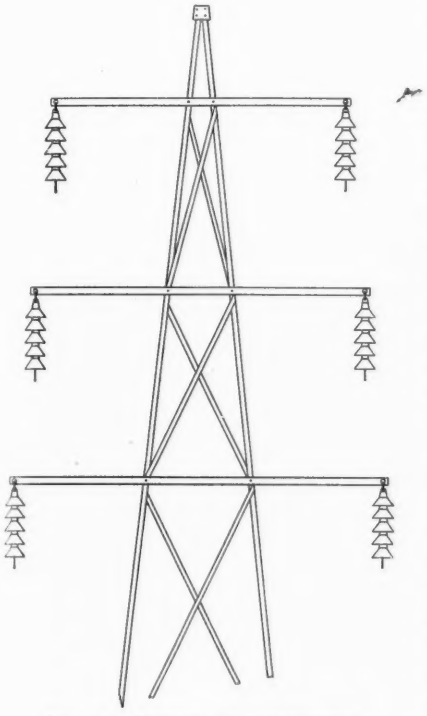


FIG. 15.—METHOD OF SUSPENDING.

dead-ending is accomplished, and how the cable is passed from one end-clamp to the other.

The underhung system of insulation works out with pleasing directness and simplicity, and its comparative cheapness argues for its wide adoption for the higher voltages. The cost of such insulators, as at present manufactured, ranges from $1.60 to $2.00 per unit, depending on the nature of the fittings. At least two fourteen-inch units would be required for 60,000 volts, and as a good 60,000-volt insulator can be secured for prices ranging between $1.70 and $2.30 each, the question of the use of suspended units for voltages below 75,000 to 80,000 is largely one of safety factor and investment.

The foregoing has given little which could be used in the determination of the proper insulator to use for any particular voltage, and it is quite in point to add here that every case is special. Insulators well suited to one locality are out of reason, in safety factor provided, for use elsewhere. A single transmission line of less than 100 miles in length may easily pass from high, clear mountain air to foggy, smoky surroundings which are a constant menace to continuity of service. Again the cost of complete immunity may well be balanced against cost of possible shutdowns—a point well illustrated in the line operating between Niagara Falls and Syracuse, all branch lines of which are equipped with much smaller and consequently cheaper insulators than those upon main lines.

It is not intended to convey the idea that every line should have a special insulator, but that the characteristics of the proposed line should be made known to the designer in order that all points may be well guarded against. It is quite likely the resulting recommendation will be upon an old-established type of which all characteristics are known, and though its use for any specific case may not call into use all it is capable of, it will quite likely prove cheaper to produce a standard article of larger size than to make a special design of just sufficient capacity.

A forecast of the future of any business, though never safe, is always interesting.

Concerning the highest practicable voltage, without reference to anything but insulators, it is safe to say that insulators for the heaviest mechanical strains and for the highest electrical stresses can be manufactured at moderate cost, so that limitations of transmitting voltages must at the present time be looked for in other directions than in insulator design, porcelain insulator design in particular.

Wherever the word insulator has been used, porcelain insulator is implied, for no other material has been so universally used in the past, and none gives such promise for the future. Its one bad characteristic, that of brittleness, is overcome by good designing; otherwise, the material is very nearly ideal for it is cheap and comparatively easy to manufacture. Of prime importance is its permanency, and of no other manufactured dielectric can as much be said. Porcelain is made under extreme conditions of heat which effect the cementing together of stable elements which have been in their present form for thousands of years, and under the conditions at present obtaining on the surface of this planet, will remain unchanged. Moreover, the porcelain is homogeneous and of a uniform texture throughout and consequently of uniform specific inductive capacity throughout, so that electrical strains are evenly distributed. On the other hand, organic materials are subject to very rapid deterioration; many unite with oxygen at ordinary temperatures or are attacked by rain water in a very short time. Heating by condenser action also aids in oxidation processes and hastens the end. A favorite method of insulating against low voltage is by means of compositions of rubber, gutta-percha, pitch, asbestos, ground mica, shellac and the like,

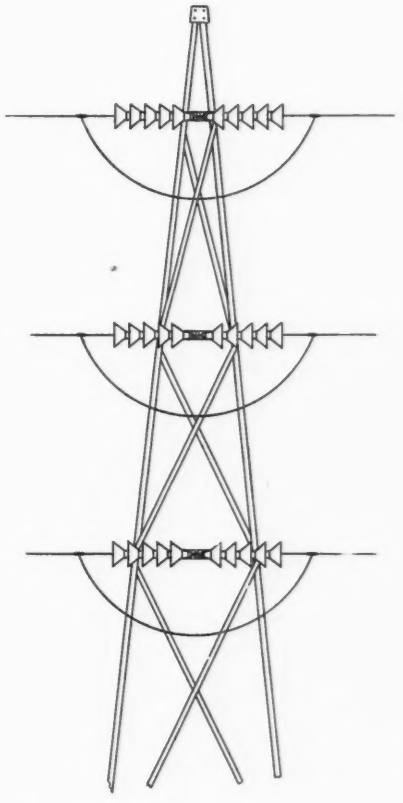


FIG. 16.—A DETAIL OF DEAD-ENDING.

but the result is always the same, and a moment's contemplation of the reasons of failure would seem to argue against their use for permanent exposed insulation.

The past is full of unhappy experiences in the attempt to insulate high-voltage lines with glass, rubber, mica, etc., and occasionally an engineer is found who is willing to erect lines of high pressure on insulators of material other than porcelain, but such engineers are so rare as to make it safe to say that, as a permanent dielectric, porcelain, to-day, stands alone.

National Electric Light Association Convention.

The thirty-first convention of the National Electric Light Association will be held in Chicago, Ill., May 19-22.

Electrical Notes from Great Britain.

(By Our British Correspondent.)

A LONDON company owning mining property in Manicaland—the Manica Copper Development Company—is about to put down machinery for the treatment of ore already available and for the more expeditious development of the mine in depth, where a marked enrichment of gold and copper values is expected. A complete equipment of electrically operated mining machinery, including rock drills and a mill and concentrating plant capable of dealing with 500 tons of auriferous copper ore per month, is to be installed. The necessary power will be transmitted from a hydro-electric generating station about two miles away on the celebrated Zambesi River. It is stated that the surface works, with the exception of the water-race, have been practically completed. W. M. Cairncross, the company's manager, has just been in London settling various matters relating to the installation.

The death of Lord Kelvin—lamented in all lands—deprived the Institution of Electrical Engineers of its president. As mentioned in these notes already, his lordship had accepted the presidency for 1907-8, but was prevented from taking up the duties of the office at the opening meeting in November owing to Lady Kelvin's illness. Later information gave reason to hope that after Christmas his lordship would be back in London and that perhaps a presidential address would then be forthcoming. How all hopes and calculations have been upset by what has happened since is too well known to need telling now. The council has elected as president for the second time Lieutenant-Colonel R. E. B. Crompton, who has had a more lengthy connection with British electrical engineering industry than most men living, and who played a prominent part in the Electrical Engineer Volunteers movement at the time of the Boer war. The new president took up office at the London meeting of the institution, held on January 9, when J. F. C. Snell's paper on "Cost of Electrical Power for Industrial Purposes" was read and discussed. The same paper was under consideration at the London meeting on January 16, while it has been also read and discussed at meetings of the Dublin and Glasgow sections during the last few weeks. Mr. Snell considers that we are nearing, if not already in them, critical times for the smaller electricity supply undertakings, and he put forward much interesting matter arguing in favor of centralization or concentration and co-operation.

The Manchester section has had before it another paper by G. W. Worrall on "Magnetic Oscillations in Alternators," in which he gave results of further investigations made by him since the reading of his last paper. These investigations concerned the oscillations taking place (1) in the main magnetic circuit, and (2) locally in the pole-face and air-gap. The paper by H. Henderson on "Electrical Power in Railway Goods Warehouses," which had to be deferred owing to the death of Lord Kelvin, has now been read before the Newcastle local section. Dr. Pohl's paper, "Notes on the Development of Turbo-Generators," read a month or two ago in London and published in this journal, has now, in accordance with the newly established arrangement, been read at the Leeds sectional meeting. In London on January 23 Rudolph Goldschmidt introduced his "Standard Performances of Electrical Machinery." Gisbert Kapp has been delivering two lectures on "The Electrification of Railways" before the Royal Institution.

According to a statement in circulation, operations have been commenced on the site of the new 30,000-kilowatt power-generating station which is to be put up by the Victoria Falls Power Company at Simmer Pan. In the first place, some half a dozen turbine-driven alternators of 3,000 kilowatts each will be installed, together with twenty-four Babcock & Wilcox boilers (evaporating 17,500 pounds each). Two of the sets are expected to be at work in about six months' time, and the other four in a year from that date. The cost is stated to be about $3,000,000, including distribution lines.

The Sunderland Corporation on January 6 formally set running a new turbo-generator set (Willans-Dick-Kerr type) at its Hylton road works. The machine is of the three-phase, alternating-current type, generating at 5,000-5,500 volts, and it is designed for a continuous load of 2,000 kilowatts at a speed of 1,500 revolutions per minute. Its cost was $52,600. The other plant installed at the same time includes four Babcock boilers with superheaters and chain-grate stokers, further coal bunkers and conveying plant. When there is so little of importance proceeding in the way of electric power station equipment, such a scheme as is on foot at Bury, in Lancashire, is deserving of mention. Here the municipal corporation has decided to spend $350,000 upon a twofold object: (1) the extension of its existing system, and (2) the establishing of generating plant to supply alternating current to manufacturers in its district. The Edinburgh Corporation is proceeding with a $25,000 to $30,000 alteration to the plant at its McDonald Road power station, by which it expects to save a considerable sum annually. An iron-lined shaft, twenty-six feet in diameter, is to be sunk to a depth of thirty-five feet, where it will intercept a main sewer running toward Leith. Screening arrangements are to be provided and centrifugal pumps will raise the water (sewage) through four eighteen-inch pipes to the condensers. Sluices and special means for dealing with the sewer gas are provided for. Willesden Corporation is about to spend $70,000 upon a new plant, meters, mains, etc.

The headway which is being made with the installation of electric driving in textile factories is generally regarded as very welcome, promoting business of a most acceptable kind. New mills are continually being added, and it is for these, of course, rather than for the older mills, that the power demand is springing up. Power companies and some municipal electricity departments generally consider that, subject to the price being reasonable, such consumers are a great acquisition to a supply system. At Oldham, however, the municipal electricity committee has stated that it is unable to supply energy for a new spinning mill at Waterhead, and that were it able to satisfy this particular consumer, others with like applications would be approaching the department. It seems that the existing installation of the city is unequal to the new demand, and that an immediate capital expenditure of $400,000 would have been necessary to meet the present application. Other calls from power consumers have been lately received, which, owing to the inadequacy of the municipal undertaking to meet them, involve a capi-

tal expenditure of $100,000. Of course, before pledging itself to large capital commitments, it is necessary for a municipality or a company to consider the financial stability of the proposed consumer and the question of the length of period during which the mill is likely to be working, but, notwithstanding these points, it would seem that there had not been a sufficiently far-sighted policy adopted in preparing for increased power demand. One member of the Oldham Electricity Committee said the other day that it was a big mistake not to have put down a plant equal to prospective demands. There is no doubt that those interested in the movement for stirring up greater enterprise in and more enlightened development of electricity supply undertakings will make use of this experience at Oldham. A new spinning mill at Stalybridge, with an installation of some 1,600 horse-power motors (aggregate), has just been completed. The necessary power in this instance is supplied from the system jointly owned by a number of municipal electric-supply authorities, and known as the Stalybridge, Hyde, Dukenfeld, etc., Electricity Joint Board.

Reference was recently made here to the rearrangement of the undertaking of the South Wales Power Distribution Company. One of the several small concerns into which the system is being divided is known as the Treforest Electrical Consumers' Company, Limited. This company has just ordered a 3,000-kilowatt turbo-generator, with complete high-vacuum surface-condensing plant, from the British Westinghouse Company, to enable it to cope with the new business that promises to come on under the altered conditions.

It is reported that the Clyde Valley Power Company is making such excellent progress in securing large and important power consumers—such as collieries (of which it has a dozen), rolling-mills (six), engineering and shipbuilding works—that both its Yoker and Motherwell generating stations are to be extended. At Yoker the available capacity is now 4,000 kilowatts, and with a rearrangement of the installation this will become 5,600 kilowatts. The Motherwell station, which also now furnishes 4,000 kilowatts, is to shortly produce an additional 5,000 kilowatts. It appears that the area is being developed in all parts, and that during 1907 the mains were extended in many directions. Among the operations at present proceeding is the construction of an overhead line from Tonnochside colliery to Garteosh, Glenboig, Coatbridge and back to Douglas Support, which, it is said, will be one of the longest overhead lines in Scotland. It will serve chiefly as a loop main by means of which 1,000 horse-power will be supplied for various motor-driven machines at the works of the Glenboig Union Fireclay Company.

Some attention has lately been paid in the newspapers here to the likelihood of fires and panics in the London tube and other underground railways. The reason for this is that on January 8, at Sloane Square Station, on the Metropolitan District Railway, an explosion and electric flashing occurred in a car. The eight passengers stepped out of the train on to the platform without any panic or alarm, and no complaint of injury was made to the officials. The car was inspected by the Board of Trade officials (Major J. W. Pringle, inspecting officer of railways, and A. P. Trotter, the Board's electrical adviser) before any repair work had been commenced or any of the effects of the occurrence removed. But before their report had been completed, or at any rate before it was made public, some of the affrighted passengers had started a correspondence in the *Times*, drawing attention to this, that and the other awful possibility. In accordance with the usual custom, the halfpenny press followed with its own contributions on the subject. Happily the Board of Trade report came out in time to prevent further fuel being added to the sensational fire. It appears that above the floor level of the car there was some blistering of varnish on the woodwork and two panes of glass were blackened with smoke and fumes. The red paint work beneath the varnish was undamaged. Below the floor level the metal pipe carrying the electric-lighting wires and a metal junction box were fused. The under side of the timber flooring was charred (one-quarter inch deep) immediately above the pipe and junction box, but there was no mark of fire inside the car. All the woodwork in proximity to the electric conductors is non-inflammable. The reporters say that this and other occurrences of a similar kind have proved that the wood will char under the effect of intense heat from electric flashing, but will not catch fire. The real combustibles were copper, iron and brass! "Such electric arcs continue until they exhaust or burn themselves out, or until the current is cut off," as was done in this case. "The ordinary method of extinguishing a fire is useless for electric arcs." It is believed that in all probability the affair was caused "by failure of the insulation of the electric lighting wires owing to damp. The heating of the wires resulted in the liquefaction of a small plug of bitumen. An explosion of bitumen followed, causing smoke and fumes. Subsequently electric flashing took place along the pipe and at the junction box under the car." The writing of alarmist letters for publication is condemned in this report, as these promote panics, which are the "main danger in any such cases of fire."

ALBERT H. BRIDGE.

London, January 25.

Chicago Street Railways Ready for Reorganization.

The Supreme Court of the United States denied, on January 23, the petition for an appeal in the Chicago street railway reorganization case. This disposes of the last objection to the plan approved some time ago by Judge Grosscup, and the reorganization of the street-car companies will now be completed.

On January 25 the property of the West Chicago Street Railway Company and that of the North Chicago Street Railway Company, which for several years were operated under the name of the Union Traction Company, were sold at auction to the Chicago Railways Company, which has been formed to undertake the reorganization of the two systems. The Chicago Railways Company offered separate bids amounting to $2,000,000, and bid a lump sum of $2,000,000. There were no other bids made. It is stated that the new company will spend $12,000,000 for new equipment and in rebuilding the lines.

Banquet of the Independent Electrical Contractors' Association of Greater New York.

On the evening of January 29 the Independent Electrical Contractors' Association of Greater New York held a banquet at Mouquin's down-town restaurant. Representatives of the Edison companies of both New York and Brooklyn and a large number of manufacturers and supply men were guests of the association. The toastmaster was C. A. Christesen, president of the association. There were 133 members present, and after the repast a vaudeville programme was rendered.

Electrical Notes from Europe.

(By Our Special Correspondent.)

THE new Brillane hydroelectric station has been recently put in operation, and it is to be ranked among the largest and best-equipped plants of the kind in France. Located in the Alpine region near the Mediterranean coast, it forms one of the extensive series of hydraulic plants which are operated by the Paris firm known as the "Energie Electrique." All the hydraulic stations and pole lines which are interconnected thus form a very extensive network which covers a large area. The Brillane station is laid out in two separate buildings. One of these is used as the turbine house and the second contains the transformers and the line switchboard. The plant is operated by a fall on the Durance River which gives a head of about eighty feet. At present there are five main groups of turbine-alternators located in the building, having a capacity of 3,000 kilowatts each. There is a main penstock for each of these wheels, while the three smaller groups, for exciters, etc., are all worked from a common penstock. The principal groups use the Francis type of horizontal shaft turbine and have three-phase alternators coupled to the wheels. In these machines the armature is fixed and the field revolves. They deliver 7,500 volts at twenty-five cycles. The auxiliary machines comprise a 200-kilowatt exciter and a fifty-kilowatt machine for use in the station, also a 250-kilowatt alternator, wound for 13,000 volts, which is used for lighting the neighboring localities. There is a second machine of this last type which serves as a standby. From the switchboard the main 7,500-volt cables are run to the transformer building.

This latter structure is laid out on an extensive scale, as it serves for a distribution centre and allows of combining the Brillane plant with the hydraulic plants of Verdon and Ventavon which are now building. The two latter plants can be used independently and connected upon the long power lines which run to Marseilles and Arles, or their alternators can be connected in parallel with those of the Brillane plant. There are three step-up transformers for each of the five alternators of the station (one per phase) and they have 900 kilowatts' capacity. The voltage is raised from 7,500 to 30,000 volts. In this case the secondaries are connected on the delta system, but when using the star connection they will give as high as 50,000 volts. In the second building there is a well-designed set of 50,000-volt bus-bars with their sectioning switches. The transmission lines are mounted on trelliswork iron poles forty feet in height and spaced 250 feet apart. Each of the poles carries six wires, three for 50,000 volts and three for 13,500 volts. At present the whole length of the high-tension lines is about 370 miles.

One of the largest storage-battery outfits on the Continent is to be installed in the new Zurich plant in Switzerland within a short time. The battery is constructed by the Olten Company, one of the leading Swiss firms. It is designed to serve as a standby and is used in the substation of Zurich. The latter is supplied from a distant hydraulic plant lying on the Albula River. For this purpose a power line about eighty miles in length is run from the turbine house to the Zurich substation. Owing to the chances of accident with such a long power line, there are two separate lines in use, and it was decided to install a storage battery which should be able to supply the whole amount of current required in case there should be a breakdown on the power line. The substation is located near the city, at Letten. The battery is used for running the standby units, and will furnish as much as 4,700 horse-power for a short time. In the station there is a composite group consisting of a three-phase alternator, a single-phase machine and a direct-current generator. In general the three-phase current from the pole line runs the first alternator as a motor, and here the generator runs empty. Should there be an accident to the line, the storage battery is coupled on to the generator by an automatic device and runs it as a motor, driving the other two machines. During the day the battery serves as a buffer upon the city tramway lines.

An electric traction line of considerable interest in Italy is the road which is to connect the localities of Chiasso and Riva San Vitale, passing by Capolago. The line is situated in the region of Lake Como and is about ten miles in length. It connects a number of towns which lie at different distances from the St. Gothard railway line and gives a direct connection between Lake Lugano and the Monte Generoso Railroad. At the same time it is the extension of the Como-Chiasso electric line and will be a means of developing the different localities through which it passes, such as Pedrinate, Castello, San Pietro and others. It is built on a one-metre gauge with a maximum grade of sixty per cent. The line will be run at 660 volts, direct current, and this will be supplied by a station which is located near the town of Lugano. The trains will be made up of thirty-six-place motor cars and thirty-place trailers. The estimated cost of the present line is $52,000.

An important project which is under discussion at Paris is that of securing a supply of current for the city from one or more hydraulic plants which would be erected on the Rhone or other streams. In this case the power lines would have an unusual length and the proposed plants would be laid out on a large scale. A commission has been recently appointed by the prefect of the Seine in order to look more closely into the question from a technical, administrative and financial standpoint. The commission, of which M. Maurice Levy is president, is composed of leading electrical engineers, mining engineers, municipal councillors and others.

One of the largest of the Italian carbide plants has lately been erected at Darfo by the Voltri Company. It is also to be used for other electrolytic work. There is a turbine plant which works in connection with the electric furnace plant. The turbine station which supplies the current for the carbide works is operated by a fall upon the Dezzo stream and uses a head of 117 metres. Two penstocks of 300 metres length bring the water to two Neyret-Brenier wheels. These are coupled to Brown-Boveri alternators which have a capacity of 4,000 kilowatts and deliver 8,000 volts. In the adjoining building are the electric furnaces, and at present each alternator supplies four furnaces of the Keller type, having a capacity of 1,000 kilowatts each. A transformer is used for each of the furnaces, and there are thus twelve of these in all. Two of them are used as a reserve. The mixture of lime and carbon is brought along above the rows of furnaces by a conveyer system and it is automatically dropped into the hoppers of each furnace. The carbide

after leaving the furnace is also handled by conveyers.

A railroad of considerable importance in Germany has been changed over to the electric system not long since. This is the line which connects Cologne with Bonn, and it is about twenty miles long. Motor-cars are used which are fitted with two four-pole motors of 130 horse-power and they are run on 990 volts. These motors can also be run on 550 volts by using another set of brushes, and are thus adapted to run on the tramway circuits of the two cities. The two end sections of the line are supplied from substations which are fed from the Cologne central plant. Current is taken from storage batteries which work in connection with boosters. The middle section of the railroad is supplied directly from the central station, using a storage battery as a buffer on the circuit.

The French Westinghouse Company is now erecting a tramway line on the single-phase system in France. It is to run between the towns of Tergnier and Anizy, passing through St. Gobain. The line is about twenty miles in length. At St. Gobain is erected the generating station for the road, and it contains two engine-driven alternators of 300 kilowatts, which operate at 3,300 volts and twenty-five cycles. The road is laid in single track of one-metre gauge, using an eight-millimetre trolley wire. Each of the motor-cars of the present road is fitted with four Westinghouse motors of forty horse-power each. There will also be run a type of freight locomotive which is designed to take a train of forty-five tons.

Among the new electric enterprises in Spain may be mentioned the new substation which is soon to be erected at Malaga for use upon the tramways of the city. Current is furnished from a distant hydraulic plant which is operated by the Chorro Hydroelectric Company, and the power line works at 2,500 volts alternating current. This is converted to 500 volts direct current by rotary groups in the substation.

Regarding the development of electric-furnace plants, the plant which has lately been installed at the works of Koechling Brothers, of Völklungen, Germany, may be noted. It now contains a Kjellin furnace of twenty tons' capacity which is designed for 1,000 horse-power. Among the furnaces lately erected in France may be cited the St. Marcel plant for carbide manufacture. Here are installed three furnaces of 2,500, 1,500 and 1,000 horse-power respectively. Messrs. Heller and Leleux are now erecting three furnaces for the manufacture of ferrosilicon which will have a total capacity of 5,000 horse-power.

C. L. DURAND.

Paris, January 25.

Lehigh University Electrical Engineering Society.

The Electrical Engineering Society of Lehigh University, a student organization, has prepared for the present school year an excellent programme for its meetings. These are held once a month, and a number of special speakers have been secured.

The first meeting was held in October, when an opening address was delivered by H. O. Stephens, and the following papers were read: "High-Speed Railway Problems," by F. T. Leilich; "The Vedado Lighting Plant, Havana," by A. A. Goytisolo, and "The State Capitol Power Plant, Harrisburg, Pa.," by C. A. Baer. Professor William Esty, head of the electrical department, also addressed the meeting.

At the meeting of the society held on November 12, three papers were read: "Electric Driving of Machine Tools," by A. J. Lowengrund; "Design of Small Hydroelectric Plants," by H. O. Stephens, and "The Electrical Engineering Profession," by Professor Esty.

At the December meeting, held on the seventeenth of the month, four papers were read: "Multiple-Unit Control of Electric Trains," by J. W. Dorsey, Jr.; "Automatic Magnetic Control of Electric Motors," by Thomson King; "Relation of Water-Power to Progress in Electrical Activity," by S. S. Seyfert, and "Hydroelectric Power Plants: A General Engineering Survey," by H. R. Lee.

At the January meeting the following papers were read: "The Mercury Arc," by E. E. Ross; "The Mercury Arc Rectifier," by F. J. Kraemer, and "Recent Researches in Radioactivity," by Professor William S. Franklin, head of the physical department. At this meeting, also, H. H. Van Staagen, of Philadelphia, addressed the society.

At the meeting to be held on February 11 a debate on "Municipal Ownership of Electric Railways and Electric Lighting Plants" will take place, and Professor L. A. Stewart will discuss "The Problem of Public Utilities."

The programme for the meeting to be held on March 10 includes: "The Electrical Engineering Apprentice," by C. H. Brillhart; "Pittsburg and Butler Single-Phase Railway," by L. F. Galbraith; "Monorail System of Railroads," by R. E. Loper, and "Railway Problems," by C. E. Clewell.

Three papers are scheduled for the meeting to be held on April 14: "Steam Railroad Automatic Signaling," by H. G. Wascher; "Power-House of Long Island Railroad," by G. O. Bason, and "Railway Tests," by E. S. Foster.

At the final meeting, to be held on May 19, the election of officers for the ensuing year will take place.

In addition to those mentioned arrangements have been made with the following engineers to address the society: L. B. Stillwell, consulting electrical engineer, New York city; Frank N. Hibbitts, superintendent of motive power of the Lehigh Valley Railroad; M. A. Maxwell, consulting engineer, Easton, Pa., and Charles F. Scott, consulting electrical engineer of the Westinghouse Electric and Manufacturing Company.

The officers of the society for the present year are: H. O. Stephens, president; E. L. Willson, vice-president; J. A. Clarke, secretary; R. E. Loper, treasurer.

Dr. Branly's Telemechanic Device.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I notice in your issue of December 28, 1907, an article by Dr. Edouard Branly describing a "new" telemechanic device. Now, I am greatly interested in the subject of telemechanical control by "wireless" methods, and Dr. Branly is to be congratulated upon the practical results which he states he has secured. I should, however, like to point out that the method is not new by any means, and is merely an elaboration of the method which I devised in 1898 and disclosed in United States patent No. 643,018. A description is also to be found in Righi and Dessau's "Drachtlose Telegraphie," so that the method should be known to any worker in this field.

The time of revolution of the discs in Dr. Branly's apparatus is given as twenty seconds; the revolution in my apparatus of 1899 occupied five seconds; but since this time even is too long for rapid control I have reduced this to two and one-half seconds in my latest apparatus. When the helm of a boat has to be altered the delay necessitated by a rotation period of twenty seconds is inadmissible.

L. H. WALTER.

92 Victoria street, Westminster.
January 25.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Tangential System of Supporting Trolley Wires.

A description is given here of a system devised by J. P. Pringle, borough electrical engineer to the Burton-on-Trent Corporation, England, for providing a flexible suspension for electric trolley lines. A trouble which used to be more serious than at present was the breaking of a trolley wire at the end of an ear. This was due to alternate bending and straightening of the wire at that point as the trolley wheel passed under it. It was to avoid this that various types of flexible suspension have been devised, in which the hanger is suspended from a short span of wire. Mr. Pringle's arrangement is, he believes, an improvement over this, as it provides a smooth surface for the wheel to run under and allows the wire to move laterally and longitudinally as well as vertically. The method consists in placing two ears on the wire, about ten feet apart. These are soldered to the wire, leaving the under surface smooth. Between these a piece of stranded steel cable is stretched, which is carried on a porcelain reel insulator, which, in turn, is supported by a metal loop carried on a second similar insulator. The suspension cable is free to move somewhat along the track, and also allows the wire side and vertical play. The effect is somewhat similar to that obtained by the messenger wire type of suspension now used for high-speed roads; in fact, Mr. Pringle suggests the use of two or three suspension cables, supported at a common point, but attached to different points of the trolley wire, for roads where the speed is high. At curves the wires are held in place by pull-overs attached to short spans of cable fastened to the trolley wire. Another advantage of this method of suspension is the doing away with composition insulators. Earthenware or porcelain may be used, which do not deteriorate with use. When this system is employed the sag of the wire may be reduced, a smoother running of the trolley wheel is obtained, and the construction is said to be no more costly than that of the ordinary bracket or span-wire type.—*Abstracted from the Electrician (London), January* 10.

Test of a Low-Voltage Alternator for Calcium Carbide Furnaces.

A brief account is given here of the performance of a 430-kilovolt-ampere alternator constructed by Mather & Platt, of Manchester, England, for a calcium carbide furnace in Ireland. The normal output is 8,600 amperes at fifty volts, but it was stipulated that the machine should carry continuously a ten per cent overload without sufficient rise in temperature to injure the insulation. The temperature rise during continuous operation at normal full load is not to be more than seventy-five degrees above that of the surrounding air. The efficiency asked for was ninety-two per cent, but the makers would guarantee only ninety per cent, although it was anticipated that the actual efficiency would be better than that asked for. It was impossible to test this machine after completion at the factory under full load, and it was agreed that the efficiency should be determined by measuring the power required to drive the machine idle at full speed, full excitation. This quantity was to be taken as the iron, windage and friction losses, to which was to be added the energy required for excitation and the computed copper loss in the armature, the total to be taken as the full-load losses. The machine was required to operate on short-circuit without injury, and the regulation was to be determined by adding together graphically the excitation required for normal voltage, no load, and for full-load current under short-circuit. In a machine for such heavy currents it was necessary to have a number of parallel circuits. It was important that these should all develop the same instantaneous voltage and run strictly in phase with each other. It was important also that no eccentricity of the revolving field should affect its performance in this way. Before coupling up the parallel circuits, these were carefully measured and the voltages were found to be identical. A further test consisted in connecting the windings in parallel by a single copper wire, No. 25 Standard Wire gauge, which fuses with a current of about twenty-five amperes. With full-load excitation it was found that this wire merely became perceptibly warm at the touch, indicating that the idle current was not more than fifteen amperes. The excitation required for full voltage, no load, was 19.6 amperes, and for full-load current at short-circuit, eighteen amperes, the graphical addition of which gives 26.6 amperes, which corresponds almost exactly to that computed for the machine at unity power-factor. The power required to drive the machine at full excitation, no load, was 15.24 kilowatts. The full-load excitation was 1.43 kilowatts, and the stator copper loss due to the full load, 8,600 amperes, was 5.75 kilowatts, making the total full-load losses 22.42 kilowatts, and giving a computed efficiency of ninety-five per cent.—*Abstracted from the Electrical Review (London), January* 17.

The Stability of Weston Cells.

A record is given here by Dr. H. S. Carhart of the performance of a number of Weston cadmium cells which he constructed in July, 1903. One of these was made up with Merck's washed mercurous sulphate, while the others were prepared from mercurous sulphate precipitated from a hot solution of the nitrate. In certain of the latter cells the cadmium sulphate solution was neutralized with cadmium carbonate, but it was found afterward that these cells were really slightly basic and for a time had a lower electromotive force than the others. At the present time they are practically identical. These cells have been kept continuously in a bath controlled by a thermostat since December, 1903, at very nearly 21.1 degrees centigrade. The mean value of these cells is now 1.01936 volts. This mean has risen slowly as the four cells mentioned above have approached the others, but the mean for the remainder of the cells has remained 1.01935 or 1.01936 for the past four years. The cells are of the H-form and are hermetically sealed. Cells set up with mercurous sulphate precipitated electrolytically, or according to the method used by the National Physical Laboratory, London, have an electromotive force of twenty parts in 100,000 lower than Dr. Carhart's cells; while the latter cells are about as much higher as compared with those at the Bureau of Standards, Washington. These cells have been compared at frequent intervals with Clark

cells set up at different times, showing undeniably that they have maintained their electromotive force for more than three and a half years. Unfortunately there are no records of comparison with the Clark cell when the cadmium cells were first set up. The cells, however, have a slightly higher electromotive force than those produced by the methods now accepted. This record, Dr. Carhart thinks, demonstrates that cells made with precipitated mercurous sulphate meet every requirement of permanency, and are fully the equal of the Clark cell in this regard, and are decidedly superior when considered from the point of view of the permanency of the containing glass cell. The Clark cells almost invariably crack at the negative electrode, due to the alloying of the platinum wire in contact with the zinc amalgam. No such difficulty is encountered with platinum and cadmium amalgam. It is, however, very difficult to seal platinum wire in glass so perfectly that kerosene oil will, after a long time, not work its way into the cell. This is a difficulty common to both types of cells.—*Abstracted from the Physical Review (Lancaster), January.*

On the Best Method of Demagnetizing Iron for Magnetic Testing.

A painstaking study has been made by C. W. Burrows in order to determine the best method of demagnetizing samples of iron before submitting them to magnetic tests. The author first gives a brief synopsis of the methods pursued by the earlier experimenters and gives as his criterion of perfect demagnetization that condition which gives a maximum induction. The apparatus used in conducting the work consisted of two magnetizing coils side by side, within which were placed the iron specimens, fifty centimetres long, which were joined at the ends by suitable wrought-iron yokes. With this apparatus the effects of varying temperature, of using various intensities of demagnetizing force, of varying rates of reversing the demagnetizing force, and of the time required to produce complete demagnetization were studied. It was found that one demagnetization, when properly conducted, was sufficient. As a result the author gives the following as the best method of procedure: the magnetic system, consisting of the test pieces and the connecting yokes, should be mounted with its plane perpendicular to the earth's field, and, if necessary, should be protected from vibrations by a pad of felt. If an accuracy of one per cent in the steep part of the magnetization curve is desired the temperature must not vary more than one or two degrees, as it is not feasible to apply a temperature coefficient correction. The demagnetization should be accomplished by a current reversed at the rate of approximately one cycle per second, while gradually diminished in such a way that the rate of decrease of the induction is, as nearly as may be, uniform. An ammeter in circuit and a rough sketch of the curve will enable one to regulate this current with sufficient exactness. The initial demagnetizing current should be sufficient to carry the induction beyond the knee of the curve, and the final current should not be greater than the smallest magnetizing current to be used. The full demagnetization may be accomplished in about ninety seconds. After a sample has been demagnetized in this way, to test its magnetic qualities, the lowest magnetizing force desired should be applied, and this should be reversed at the same speed in which the piece was demagnetized. This reversing should be continued until two deflections, about twenty-five reversals apart, show only a negligible difference. The final deflection is then the normal value. Without demagnetizing again, the next higher magnetizing force should be applied and reversed as before, and the process continued until all required points have been obtained.—*Abstracted from the Bulletin of the Bureau of Standards (Washington), January.*

Electric Welding.

A description is given here by C. B. Auel of a method of using the electric arc for welding and repairing defective iron work. The author first divides methods of welding into four classes: the Zerener, in which an arc is drawn between two carbon electrodes and caused to impinge on the metal to be welded, by means of an electromagnet; the La Grange-Hoho, otherwise known as the "water-pail force;" the Thomson, or incandescent process, in which heavy alternating currents are passed through the joint to be welded; and the Benardos process, in which an arc is drawn directly between the metal to be welded and a carbon electrode. This latter process is simple and suitable for many uses, and does not require an elaborate equipment. Its application to shop methods is described somewhat in detail. The outfit needed is a controlling rheostat, which may be of the grid type or two water rheostats improvised for barrels, a carbon electrode, fire clay or carbon blocks for molding purposes, and a source of supply which can furnish from seventy-five to 100 kilowatts, at from 100 to 125 volts. The operator should have a canvas hood with a colored glass window for covering the head and protecting the eyes, and should wear gloves with gauntlets to cover the wrist. A higher voltage than 125 may be utilized, but this is wasteful. A portable generating set consisting of a motor-driven generator with suitable output, provided with a controlling switchboard, is convenient. The water rheostat may be formed of two water-tight barrels placed side by side, into each of which dips a triangular electrode of steel plate about one-quarter of an inch thick, suspended by means of pulleys and counterweights. The barrels are joined in parallel in the arc circuit. Two discarded castings, weighing about thirty pounds each, may be used for the bottom electrodes in the rheostats. The carbon arc electrode is held in a clamp attached to an insulated handle provided with a shield to protect the hand. A hard, solid carbon about one and a half inches in diameter and six to twelve inches long is suitable. When used it should wear away to a round stub end and not to a long point. For repairing steel castings an iron rod about three-eighths of an inch in diameter is used. For filling, Norway iron is preferable, though scraps of boiler plant or steel castings may be used. To make a weld the positive terminal of the circuit is clamped to the casting to be welded, so that the current will flow from the metal to the carbon. The carbon is then placed in contact with the metal and drawn away so as to strike an arc about two inches long or more. The arc is allowed to play upon the casting until the metal commences to boil. The electrode should be manipulated so as to heat the casting thoroughly within the immediate vicinity of the proposed welding. This will prevent too rapid cooling of the molten metal. When the metal is boiling, one end of an iron rod is placed into it and is allowed gradually to melt away until the opening is filled. The operation should be carried out continually to avoid the formation of slag. When, instead of filling the cavity, it is necessary to build up, a mold is formed of fire-clay or blocks of carbon; or motor brushes may be used for this purpose. The process just described is then carried out. If the work is done properly, the weld has a tensile strength about seventy-five per cent of that of the original stock. Data taken from a typical weld show that a hole one and a quarter inches in diameter by two inches deep was filled in fifty-six seconds, the voltage across the arc varying from sixty-three to fifty, the current varying from 550 to 650 amperes.—*Abstracted from the Electric Journal (Pittsburg), January.*

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Series Luminous Arc Rectifier System.

One of the most interesting and important developments in arc lighting systems is the development by the General Electric Company, Schenectady, N. Y., of its series luminous arc rectifier, permitting the operation of direct-current luminous arc lamps from alternating-current central stations. The luminous arc lamp, on account of the volume and character of its illumination and the low energy consumption per candle-power, is particularly suited to street lighting. It has already been installed on many up-to-date outdoor systems, where its brilliancy and light distribution make it an ideal illuminant. Its small power consumption—four amperes at seventy-five to eighty volts—also appeals to central station managers. The combination of this new lamp with the efficient transformation of alternating current into direct current by means of a mercury arc rectifier gives a novel and practical solution of this important illuminating problem.

Fig. 1 shows the luminous arc lamp for use with the series rectifier system, Fig. 2 showing the mechanism of the series luminous arc lamp. The main frame of the lamp consists of a single large tube which acts as a chimney and carries away the fumes of the arc. Wind shields are placed at the top of the lamp to prevent downward drafts into the tube. The electrodes differ entirely from ordinary carbon arc lamp electrodes. The upper electrode consists of a bar of hard-drawn copper supported by iron wings. The lower electrode is made of specially prepared composition contained in an iron tube five-eighths inch in diameter by eight inches long. A horizontal reflector is placed inside the globe in close proximity to the arc, and serves to throw a large volume of light below the lamp without interfering with the main distribution of light in the horizontal direction.

FIG. 1.—SERIES LUMINOUS ARC LAMP.

When the lamp is out of circuit its electrodes are separated with the lower electrode carrier detained by a stop, which holds the tip of the lower electrode at a fixed distance from the upper electrode. When the current is thrown on, the pick-up by the starting magnet brings the lower electrode into contact with the upper electrode. This operation allows the current to flow through the series magnet, thereby opening the circuit of the starting

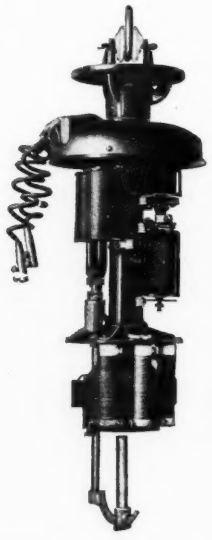


FIG. 2.—MECHANISM OF SERIES LUMINOUS ARC LAMP.

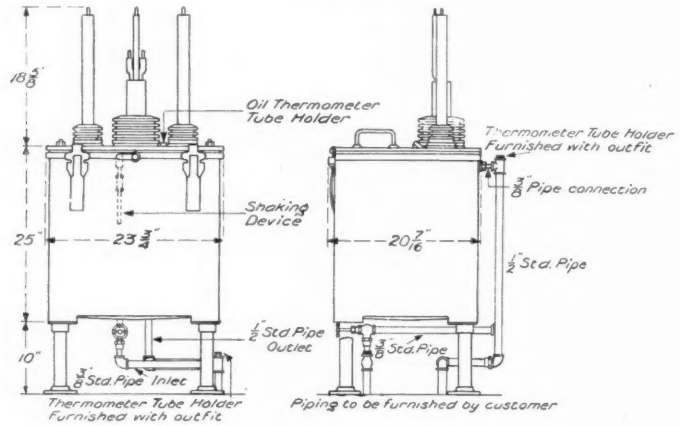


FIG. 3.—DIMENSIONS OF OIL TANK FOR RECTIFIER.

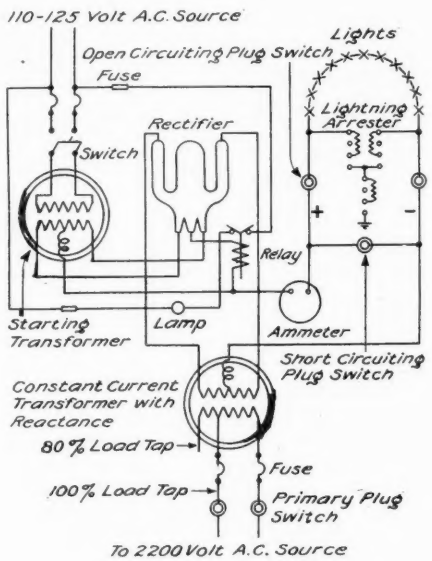


FIG. 4.—DIAGRAM OF CONNECTIONS, SERIES LUMINOUS ARC RECTIFIER SYSTEM.

magnet at the cutout contact, allowing the lower electrode to fall and strike an arc. The lamp is then burning with the lower electrode carrier resting on its stop, and with the series magnet holding the cutout contact open. As the lower electrode is consumed, the voltage across the arc increases until, at a given limit, the shunt magnet (which is bridged across the arc) lifts its armature and closes the cutout contact. The closing of this contact cuts the starting magnet again into circuit, thereby picking up the lower electrode and reestablishing the arc at the proper distance.

The station equipment of the series luminous arc rectifier system includes a constant-current transformer connected to the alternating-current source, and a series mercury arc rectifier panel with its accessories. The primary windings of the transformer may be designed for an alternating-current supply of practically any voltage or frequency. The secondaries are connected to the anodes of the rectifier tube. A tap at the middle of the secondary connects the transformer through a direct-current reactance to the direct-current circuit on which the lamps operate.

The direct-current reactive coil used with the fifty, seventy-five and 100-light sets is mounted on the base of the constant-current transformer and enclosed in the same casing that surrounds the transformer mechanism. The coil used with the twelve and twenty-five-light sets is contained in a separate casing external to the transformer.

The rectifier tube in which the alternating constant current is changed to direct current for the series-current distribution consists of an exhausted glass vessel containing one positive anode or terminal in each of the two upper arms, two mercury starting anodes, and the mercury cathode or negative terminal at the bottom of the tube. The rectifier tube is immersed in oil and supported in a movable wooden holder. The tube is put into operation by shaking it slightly, which cause a mercury bridge to be formed and broken between the starting anodes and the cathode. The dimensions of the tank for the rectifier tube are shown in Fig. 3.

Under normal operating conditions the average life of the tubes on twenty-five, fifty and seventy-five-light circuits is considerably over 400 hours.

A special exciting transformer of about 100 watts' capacity is used in starting the rectifier tube. The primary is connected to a 110-volt supply, and the secondary to the tube's starting anodes, with a tap in the middle of the secondary connected to the cathode or negative terminal at the bottom of the tube. After starting the tube, the exciting transformer can be disconnected from the low-voltage circuit by a switch on the panel.

An iron tank (shown in Fig. 3) contains the oil, which is kept at a proper temperature by means of water flowing through a cooling coil.

Fig. 4 shows the diagram of connections for the series luminous arc rectifier system. The twelve, twenty-five and fifty-light switchboard consists of a single piece of blue Vermont marble twenty-eight inches by twenty inches by one and one-half inches thick, supported on a frame sixty-four inches high. These boards are designed for installation immediately in front of the constant-current transformer, and are not a portion of a complete switchboard.

MEETING OF DEPARTMENT MANAGERS AND DISTRICT MANAGERS, ALLIS-CHALMERS COMPANY, AT WEST ALLIS, MILWAUKEE, WIS., JANUARY 6.

Department and District Office Managers Allis-Chalmers Company.

The photograph reproduced herewith, which was taken in front of the Allis-Chalmers Club at West Allis, Wis., represents a gathering of department and district office managers of the Allis-Chalmers Company from every industrial centre of the country. During the entire meeting, which lasted four days, beginning with a tour of inspection of the mammoth works at West Allis and ending with a banquet at the Hotel Pfister in Milwaukee, the prevailing note was that of decided optimism. With the possible exception of a single district, which depends for its prosperity upon one particular product, reports indicate that a general resumption of business activity is being brought about at the present time, and the outlook for purchases of material of all kinds, particularly power and electrical machinery, is most encouraging. Many of the district managers stated, in fact, that during the past two weeks inquiries have been very heavy, and customers are only waiting until a little more complete restoration of normal conditions to place large orders for apparatus.

One of the facts emphasized at the meeting was the advantage both to Allis-Chalmers Company and the purchaser of taking contracts for the complete equipment of power and lighting plants, electric railway installations, industrial works, such as cement mills, flour mills, saw mills, ore-reduction works, stone-crushing plants, etc., which the company's varied line of machinery enables it to do, thereby eliminating any division of responsibility and insuring the harmonious working of all parts of the apparatus, from bearing boxes, gears and pulleys to the heaviest machinery used in the plant, of whatever character it may be, thus guaranteeing the operation of the plant as a unit rather than the performance of the individual parts.

Following is a list of the managers shown in the photograph: F. C. Colwell, manager Cincinnati district office; J. U.

Jones, manager Dallas district office; E. T. Pardee, manager Boston district office; M. W. Thomas, manager Atlanta district office; J. F. Harrison, manager flour-mill machinery department; B. A. Behrend, chief electrical engineer; J. W. Gardner, manager Chicago district office; J. Weidman Murray, manager Pittsburg district office; W. L. Loveland, manager mining machinery department; St. J. Chilton, manager Philadelphia district office; F. L. Bunton, manager St. Louis district office; F. C. Randall, manager New York district office; Roscoe Cornell, manager El Paso district office; Geo. A. Williams, manager Cleveland district office; P. H. Carey, manager Detroit district office; C. R. Tatem, manager Buffalo district office; H. D. Scribner, manager San Francisco district office; A. E. Mosier, manager Kansas City district office; A. H. Whiteside, manager electrical department; R. B. McConney, manager Denver district office; L. M. Harvey, manager Milwaukee branch office; E. T. Adams, manager gas-engine department; J. H. Denton, manager air-brake department; I. L. Skeith, manager saw-mill machinery department; M. C. Miller, assistant to the president; W. J. Sando, manager pumping-engine and hydraulic-turbine departments; W. E. Dodds, manager steam-engine department; J. C. M. Lucas, manager Baltimore district office; H. Schifflin, manager crushing and cement-making machinery department; W. H. Powell, superintendent electrical works; J. R. Jeffrey, secretary Bullock Electric Manufacturing Company.

Power Company Not Taxable.

An opinion has been handed down by Judge Hassler, at Lancaster, Pa., in the case of the York Haven Water and Power Company, which is developing a large electric power plant on the Susquehanna River. This company is assessed at $500,000, and the township of Conowago, as well as Lancaster County, would derive a good revenue from the taxes. The Court holds, however, that the company is a quasi-public corporation, and is not subject to local taxation.

A New System of Lighting.

A new system of lighting by incandescent lamps has been devised, known as the Linolite system, which employs a long tubular lamp in which the filament reaches from end to end. As the lamps are connected end to end, they form a continuous line of light, hence the name "Linolite." The source of light being continuous, the illumination is uniformly distributed, and the alternate bright and dark spots, characteristic of lighting with bulb lamps, are eliminated.

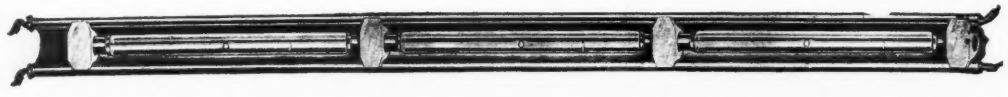


FIG. 1.—THE LINOLITE SYSTEM OF LIGHTING. THE INCANDESCENT FILAMENT STRETCHES FROM END TO END OF THE LAMP UNITS, WHICH ARE ASSEMBLED IN A SEMI-CIRCULAR TROUGH REFLECTOR.

The lamps are arranged in a semi-circular reflector (Fig. 1) which is made up in any lengths required up to and including ten feet. The position of the lamp relative to the reflector is such that the filament is located uniformly throughout its length in the focus of the reflector, and thus a maximum of reflecting efficiency is obtained. As a result, tests have shown that the illumination secured with the Linolite system is greater than that with ordinary bulb lamps.

Another advantage of the Linolite system is the small space which it requires. The entire reflector is two and one-quarter inches wide by one inch deep over all, so that it can be placed in show windows, show cases, etc., back of the window frames or fillets, in such manner that the fixture will be invisible, or practically so, and the source of light screened entirely from the eye of the spectator.

Fig. 2 shows the distribution of luminous intensity with the Linolite system as compared with an ordinary sixteen-candle-power lamp in its end-on position, both having the same size and length of filament and consuming the same current. This curve is the result of a certified test made by the City and Guilds of London Institute, London, England. The solid curve shows the candle-power in any direction of the bulb lamp while the dotted curve shows the corresponding values of the candle-power of Linolite. It is notable that while the illumination given by the bulb lamp immediately in front is seven to eight candle-power, that of Linolite is over forty candle-power.

The Linolite system is particularly adapted for lighting show windows, show cases, pictures, signs, desks, etc., also for theatrical stage lighting and the outlining of buildings for display purposes. An important application of it is in the illumination of room interiors by reflected light, in which case it is placed above the cornices near the ceiling, from which the light is reflected.

This system is manufactured by the H. W. Johns-Manville Company, of New York.

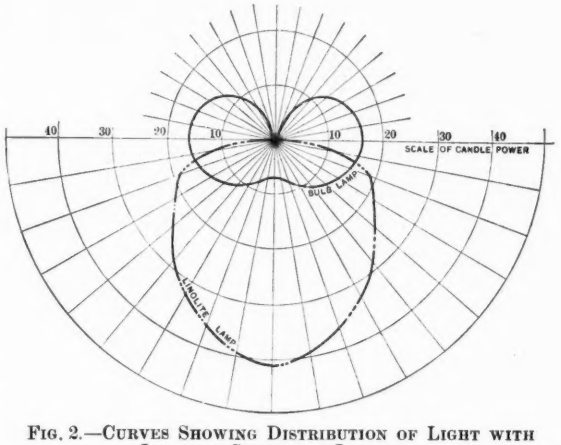


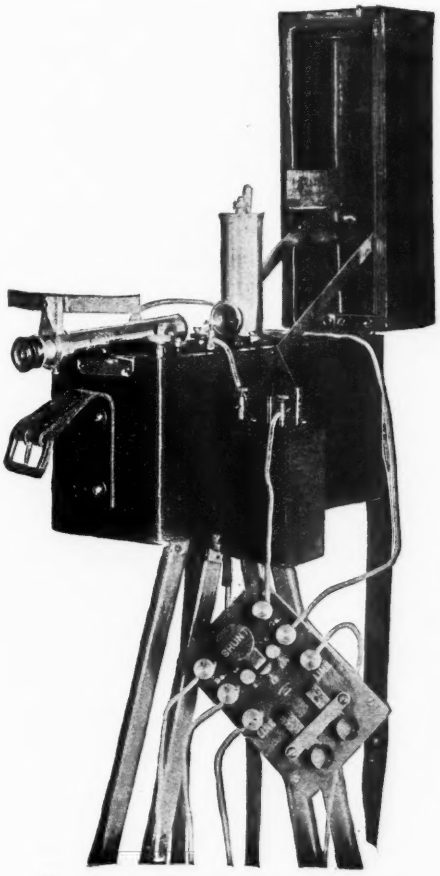
FIG. 2.—CURVES SHOWING DISTRIBUTION OF LIGHT WITH LINOLITE SYSTEM OF LIGHTING.

Electric Reduction of Zinc in Canada.

United States Consul L. E. Dudley, of Vancouver, British Columbia, reports that a new zinc-reduction plant is being constructed in British Columbia by the Canadian Zinc Company. The plant is said to be nearing completion, and it is expected to be ready for operation by the first of February. An electrical method of reduction is to be employed, though no description of the process is given. Much of the lead ore obtained from the Slocan mines in British Columbia contains over ten per cent of zinc, for which the producers are penalized by the lead refineries. As a consequence of this a number of these mines have been closed, but the establishment of these zinc works, which are at Nelson, is expected to make their working profitable.

A New Universal Galvanometer.

All the advantages of the pivoted form and the added sensibility of a suspended instrument are combined in the Queen universal galvanometer just produced. The permanent magnets are made from the finest quality of magnet steel, carefully aged to insure permanency. The moving coil swings in a uniform magnetic field and the deflections are proportional to the flow of current. With proper shunts this instrument can be used as an ammeter or a milli-ammeter, and with a



NEW QUEEN UNIVERSAL GALVANOMETER.

series resistance can be used as a voltmeter or a milli-voltmeter.

As a galvanometer proper it has a variety of uses, having ordinarily a sensibility of 150 to 500 megohms, and is made up to 1,000 megohms sensibility. The coils are rectangular in form and swing over a soft iron core having radial faces. The moving system is suspended by phosphor bronze strips secured to abutments terminating at the ends of two steel rods that also hold the soft iron core over which slides the clamping device for transportation. A three-eighths-inch plain mirror is mounted just above the coil. The upper abutment is provided with two milled heads, one for locking the system and the other to adjust zero. The whole is enclosed in a brass tube provided with a three-quarters-inch circular window.

The entire system can be lifted from the tube by the removal of two small screws. The tubes with system are interchangeable. This will enable the user to have tubes of different sensibilities.

The containing cases are made of hardwood, well finished and provided with a leather carrying strap. The permanent magnet is securely bolted in the case, thereby insuring extra stability.

A telescope and scale is also attached to the magnet, as well as curved soft iron pole pieces that form a receptacle for the tube and system. On either side of the telescope is provided a mill-head screw for leveling when used as a table galvanometer. There is also provided a brass plate secured to the lid of the instrument, so that it can be used as a wall galvanometer. This instrument has also a brass plate on the bottom with a hole tapped to receive the screw from a tripod for street work.

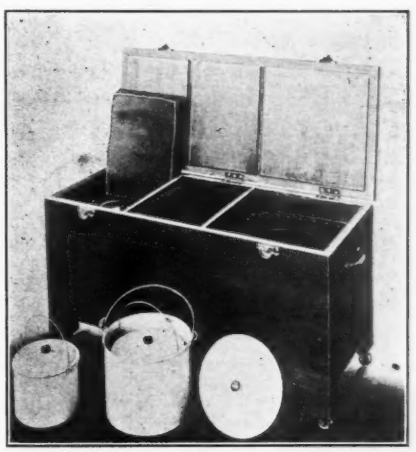
With this instrument is a 100,000-ohm coil wound with a wire having a negligible temperature coefficient, mounted in a neat case with suitable terminals. There is also an Ayrton shunt with all necessary binding posts and two battery reversing keys. These instruments all fit in the box very compactly and the entire dimensions over all are six and one-half inches high, eight and one-half inches long and three and one-half inches wide, weighing five and one-half pounds.

The Queen universal galvanometer is manufactured by Queen & Company, Philadelphia, Pa.

The "Autotherm."

One of the interesting contrivances which have been developed for culinary purposes, and which is now attracting a great deal of attention in connection with the utilization of electricity for heating and cooking, is the "Autotherm," invented and built by W. S. Heger, Jr., 193 Western avenue, Milwaukee, Wis. The "Autotherm," or "fireless cooker," is of great advantage in residences, hotels and restaurants where electricity is used for heating and cooking. There has been some dissatisfaction with electrical cooking, due to the cost because of the high rates charged by the central station companies. Where it is not possible, because of local conditions, to reduce the rates for electricity so that the cost of cooking becomes comparable with that for gas or coal, the "Autotherm" will be found of great advantage.

The principle of this device is in retaining the heat in the partially cooked material until the cooking process has been completed. It is not necessary to re-write the ordinary cook book to make use of the apparatus. All that is necessary is to bring the material to be cooked up to the cooking temperature for a few minutes, and then remove the utensil and place it in the "Autotherm." By the proper utilization of insulating materials the heat is retained in the utensil, and the cooking process completed without further expenditure of energy.



THE "AUTOTHERM" (FIRELESS COOKER.)

Westinghouse Lamp Company to Discharge Receivers.

It is learned that the Westinghouse Lamp Company, manufacturer of incandescent electric lamps, and one of the constitutent companies of the Westinghouse Electric and Manufacturing Company, has obtained the signatures of ninety-nine per cent in amount of the creditors to the readjustment plan permitting a discharge of the receivership. The receivers have found the company's financial condition to be entirely sound, the assets being approximately five times as great as its liabilities. The formalities connected with the application to the court for a discharge of the receivers are now under way and it is expected that the company will be returned to its shareholders by March 1. The business of the company has continued without interruption during the receivership.

The officials of the company are expecting to have the new plant at Bloomfield, N. J., in operation before the end of the summer. It will have a capacity of over 15,000,000 lamps per year.

INDUCTION MOTOR STARTERS.

BY D. E. CARPENTER.

The conditions under which electric motors and their auxiliaries are frequently compelled to operate in cement mills, steel mills, foundries, machine shops, etc., are often far from theoretically ideal, and the problem of adapting motors and their auxiliaries to practical conditions instead of trying to make the conditions perfect, has been presented to electrical engineers for solution. In the design of starters for induction motors the following conditions and requirements should be given careful consideration.

Instead of being located where it can

WESTINGHOUSE TYPE 491 HF STARTER COMPLETE.

be kept ideally clean, a condition formerly thought to be essential to successful operation, electrical apparatus used in many industrial plants must be capable of operating constantly in an atmosphere filled with dust and flying particles, and must require almost no attention except a periodical inspection by the electrician, and an occasional supply of fresh oil to the bearings.

Motors and their starters must be ready to perform their several functions promptly and without failure, even though the operators may be absolutely ignorant of even the elementary principles of electrical engineering; in other words, the motors and their auxiliaries must be foolproof, this expression being used without reflecting, in the least, on the operators' general intelligence or knowledge of the industrial processes they are performing.

In a well-managed mill or factory, frequent or prolonged shut-downs on account of lack of power can not be tolerated, and electric motors, no matter how convenient they may be, can not compete with other forms of motive power unless the motors are absolutely reliable in service. With motor-drive, failure of power from any cause must, of course, be charged to the system. Not only must motors be reliable, but there must be no failures due to poorly designed or poorly constructed motor starters. Such starters may fail in themselves, or they may start the motors under such conditions as to cause them or some of their other auxiliaries to fail. For example: An incorrectly designed motor or motor starter may result in an excessive starting current, thus continually blowing fuses or opening circuit-breakers; or the motor may start with such a shock as to break something.

For best results with induction motors, the starters must be designed especially for the type of motor with which they are to be used. It is a mistake to assume that an induction motor can be used successfully with any type of motor. Some motors require much more current to start with a given torque than others, or have other individual characteristics requiring an especially adapted starter.

If motors and lights are operated from the same circuit, the motor-starting current must be limited to a value that will not seriously disturb the line voltage. The importance of this requirement depends on the relative importance of the power and the light. In many industrial operations power is of first importance and some momentary decrease in the candlepower of the lamps operating from the same generator or transformer as the motors may be permissible.

In cement mills and in steel mills, the constant speed motors are often required to start with a strong torque and to accelerate this torque to full speed. The starting voltage impressed on the motor stator must, therefore, be a considerable percentage of the full line voltage. For such work two steps in the starter are usually sufficient to bring the motor to full speed without serious shock either to the electrical system or to the connected mechanical apparatus.

The electrical devices should be so controlled as not to endanger life or property. In many operations the air becomes filled with fine dust so inflammable that its ignition would be disastrous. Squirrel-cage induction motors, being without moving contacts, are especially suited to such locations, but the auxiliary devices used with the motors must have no exposed circuit opening parts. All electrical contacts and circuits must be thoroughly and effectively insulated. There must likewise be no opportunity to receive an electrical shock on touching any part of the starter case or handle.

It is quite a common error to give preponderant consideration to the first cost of an article, and not enough to the length of the period during which the article will give satisfactory service. A better way would be to consider the cost per unit

WESTINGHOUSE TYPE 491 HF STARTER COMPLETE, TWENTY TO SEVENTY-FIVE HORSE-POWER CAPACITY.

length of useful life, this cost to include both the first cost and the cost of repairs during the period.

A motor starter that requires frequent repairs or renewals of worn parts or on which renewals, when necessary, are hard to make, may be comparatively expensive even though its first cost is low; few repairs should be necessary and these should be easily, quickly and cheaply made.

The Westinghouse cement-type starter, technically known as the type E two-point auto-starter, was especially designed for use with its type CCL squirrel-cage induction motors which start full-load torque with unusually low current. This starter operates by varying the voltage impressed on the motor field; it consists essentially of two auto-transformers and two sets of oil-immersed switch contacts, all enclosed in an iron case, the bottom of which forms the oil tank. The switches

are operated by means of a lever having three positions, *viz.*, the off position, the starting position and the running position. The lever is locked in the off position and in the running position by a spring catch, but will not remain in the starting position unless held, and on being released will immediately return automatically to the off position.

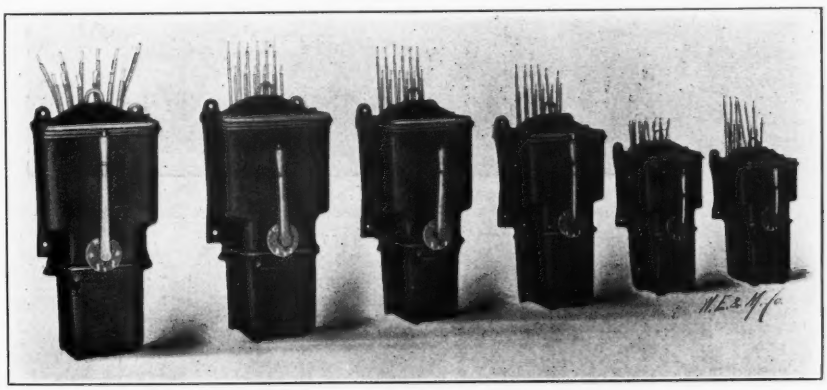
The switches consist of copper rods abutting against brass rods, this combination of metals having proved very satisfactory in resisting injury from arcing. Firm contact is maintained by coiled springs which are compressed about one-half inch in closing the switch whether in the starting or the running position. The arcing tips are screwed onto the ends of the rods and may be removed or replaced with a pair of ordinary gas pliers. The contacts are always opened in oil so that they wear away very slowly. In practice it is found that the conductivity of the arcing tips increases slightly with use. When the two abutting tips have each been shortened about one-quarter inch, that is, the total compression of the springs decreased one-half inch, the tips should be replaced with new ones. The necessity for such renewals will occur only after the circuit has been broken several thousand times.

The switches are accessible on lowering the oil tank. The larger tanks have a hole near the bottom for draining off the oil, but the smaller ones can be handled without draining. A hole for filling is provided at the oil level near the top of each tank.

The auto-transformers are contained in the upper part of the case. Taps are provided on each transformer coil so that the voltage impressed on the motor fields at starting may be made fifty, sixty-five or eighty per cent of the full line voltage. Unless otherwise ordered, the starters are sent out connected for sixty-five per cent of full voltage at starting, with instructions to use the lowest starting voltage that will give sufficient starting torque.

The leads carrying the motor-starting current are separate from those carrying the running current, and are in use only while the lever is held in the starting position. These leads may or may not contain overload protecting devices. The leads carrying the running current are not in use until the lever is thrown over to the running position and must contain fuses or circuit-breakers for overload protection. The accompanying diagrams indicate the connections for both two-phase and three-phase circuits, and show fuses only in the leads carrying the running current. Full protection from excessive running or starting current may be had by using a circuit-breaker and providing the trip coils with an intermediate tap, so that the starting current will traverse only a portion of the turns.

WESTINGHOUSE TYPE 482 HF STARTER COMPLETE, 100 TO 200 HORSE-POWER CAPACITY.



A NEW LINE OF INDUCTION MOTOR STARTERS.

In starting, the lever is unlocked from the off position by pressing the button in the end of the handle, and is moved to the starting position about thirty degrees to the left of vertical, where it is held until the motor speed has nearly reached its maximum. The lever is then thrown quickly over to the running position, about thirty degrees to the right of vertical, where it is automatically locked. The movement from the starting to the running position must be quick, otherwise the lever will lock in the off position. This feature prevents the lapse of sufficient time in passing from the starting to the running position to allow the motor to slow down. The automatic locking device, that catches the handle in the off position as just indicated, is very simple but always effective; it is contained inside the tank just above the oil level, and is kept well lubricated by the spray of oil that rises as the switches operate. The starter handle can not be moved from the off position directly to the running position, but must first be placed in the starting position as already indicated.

Lugs are provided for mounting the starters against a wall. The cover is easily removed from the top of the case leaving all connections in plain view and easily accessible.

These starters are built for twenty-five and sixty-cycle motors of from five to 100-horse-power capacity for 220, 440, 500 and 2,000-volt circuits, and for sixty-cycle motors up to 200 horse-power at 440 volts and above.

For operation on circuits where close voltage regulation is essential and where, at the same time, considerable starting torque is required, induction motors provided with wound secondaries and collector rings are preferable to squirrel-cage motors. By means of variable starting resistance in series with the collector rings, smooth and easy starts can be obtained with starting current not exceeding approximately full-load current.

Westinghouse HF motors and HF starters are built to operate together as just indicated. An HF starter consists of three sections of resistance, connected in star for small current capacities and in delta for large capacities, and a series of contacts with a contact changing device by means of which the resistance can be gradually short-circuited.

HF starters for motors up to 200-horse-power capacity are entirely self-contained, the resistance and contacts being enclosed in cylindrical iron cases that are weather-proof when mounted in an upright position. For motors larger than 200 horse-power rheostatic drum controllers and

separate cast-iron grid resistances are used.

In the smaller controllers, five to seventy-five horse-power, the resistance is bar-wound, that is, resistance is wound on asbestos-covered metal strips. The steps of the resistance are connected to copper contact segments on the face-plate, and over the segments plays a three-armed contact switch operated by means of a hand wheel above the cover. For motors of fifteen-horse-power capacity or less, six steps are used, and for the larger motors up to seventy-five horse-power, eight steps.

For motors of from 100 to 200-horse-power capacity, three self-contained sections of cast-iron grid resistances are arranged within a cylindrical iron case. Bosses on the grids fall in line and are ground to form a surface over which short-circuiting brushes play. The brushes are moved up and down in the interior of the controller by a screw operated by means of a hand wheel. The nut constituting the brush-holder is held from turning but is free to move axially along the screw. The brushes are made of copper and are easily renewable. The time required for the brushes to complete their travel precludes the possibility of making a sudden start. A pointer on the outside of the case indicates the position of the brushes.

For starting motors of from 250 to 900-horse-power capacity the rheostatic controllers contain three drums each. Up to 500 horse-power the controllers have nine starting points and above 500 horse-power twelve points. The three drums are mounted between end castings and are enclosed by a sheet-metal casing; all three are operated by means of one handle. The segments and fingers have sufficient carrying capacity for continuous service on any point so that by using a properly proportioned resistance these controllers can be used for operating the motors on reduced speed as well as for starting purposes.

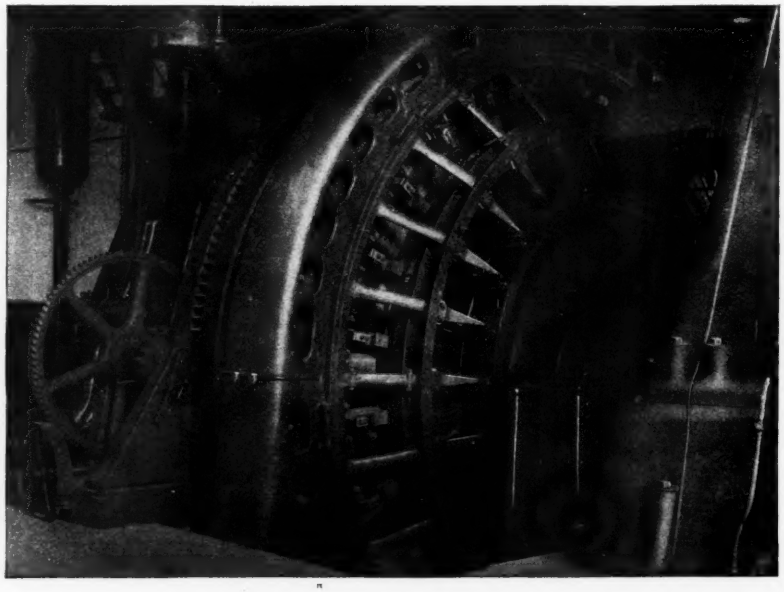
San Francisco Electrical Contractors' Association.

The annual banquet of the Electrical Contractors' Association of San Francisco, Cal., was held on January 19 at the Fairmont Hotel. The affair was purely informal, and was given for the purpose of bringing the members of the trade into closer social touch. Over eighty persons, representing all the different departments of electrical work—jobbers, engineers, contractors, etc.—were in attendance. The president, Robert W. Martland, called upon the guests at random for impromptu speeches.

COMMUTATING-POLE GENERATORS IN POWER PLANT OF BOSTON ELEVATED RAILWAY COMPANY.

TWO DIRECT-CURRENT UNITS WITH A COMBINED NORMAL (NOT OVERLOAD) CAPACITY OF 5,400 KILOWATTS.

Among the comparatively recent improvements made in the design of direct-current machines, probably none has done more to mark a distinct advance in the art than the employment of commutating poles. While commutating-pole machines of moderate capacity have been in successful operation for some time past, it is only recently that this feature has been applied to large direct-connected engine-driven generators operating under the severe service conditions generally met with in street railway work.



575-VOLT RAILWAY GENERATOR, CHARLESTOWN POWER STATION OF BOSTON ELEVATED RAILWAY COMPANY.

The two 2,700-kilowatt commutating-pole railway generators recently installed in the Charlestown and Harvard power stations of the Boston Elevated Railway Company by the General Electric Company present some interesting features in connection with the design, installation and operation of this type of railway generator.

The first of these generators was put in commercial service on October 10, exactly eight months from receipt of order and twenty-one days in advance of the date specified for delivery. This is the quickest delivery on record for an engine-driven unit of this size. The second machine, although completely installed and ready for operation before the middle of November, was not placed in service until several days later, owing to non-completion of other work in progress of erection in the station.

These generators are direct-connected to McIntosh & Seymour 4,100-horse-power, vertical, cross-compound engines and are designed for 575 volts at a speed of ninety revolutions per minute, but are capable of a wide voltage range at all loads. Although the largest commutating-pole railway generators ever built, at the same time they are of smaller physical dimensions and occupy less floor space than any machines of same output and speed previously constructed. It is interesting to note in this connection that the armature diameter of these machines is approximately four and one-half feet less than the armature diameter of the non-commutating-pole generators of the same output just installed in the Lincoln Wharf station of the Boston Elevated company.

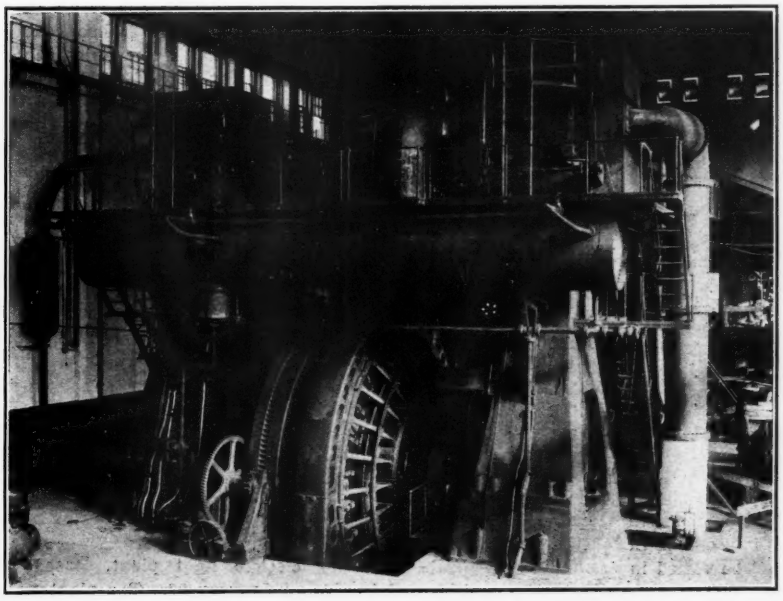
The generators are guaranteed to deliver 2,700 kilowatts (4,700 amperes at 575 volts) continuously with a temperature rise not to exceed thirty-five degrees centigrade in any part above the surrounding air, also fifty per cent overload or 4,050 kilowatts (7,050 amperes at 575 volts) for two hours following the normal run, temperature rise not to exceed fifty-five degrees centigrade, and to withstand a momentary overload of 100 per cent or 5,400 kilowatts (9,400 amperes at 575 volts) without injury.

That these guarantees have been fully met has been clearly demonstrated since the machines have been put in service. Their operation under the severe condi-

tions imposed by a fluctuating railway load has been entirely satisfactory in every respect, and tests taken show an extremely low temperature rise that is within the guarantee by a very large margin.

The practically sparkless commutation secured under all conditions of load by conservative design and use of commutating poles reduces wear of commutator and brushes to a minimum, which is an additional source of economy obtained with this type of generator.

No change whatever in the brush setting has to be made from no load to momentary overload condition of 100 per cent, and the circuit-breaker can be tripped under any condition of load between these limits without appreciable disturbance at the brushes. In fact the provision for shifting brushes is almost superfluous on this type of machine, as with the brushes once adjusted for best commutation it is never necessary to alter their position.



575-Volt Railway Generator, Charlestown Power Station of the Boston Elevated Railway Company.

Considerable doubt was expressed in certain quarters as to the possibility of obtaining successful parallel operation of this type of generator with other machines of the non-commutating-pole type on so large and complicated a system as the Boston Elevated Railway, but that this fear was ungrounded is proven by the fact that no trouble whatever was experienced in paralleling these machines with others in the stations where they were installed.

The magnet frame is of cast-iron, rectangular in shape, made in six sections securely bolted together and of the box-section type, forming a most rigid structure for supporting the numerous poles with their heavy field coils. The main poles are rectangular cast-steel, with laminated pole-faces and the commutating poles are laminated throughout. Field coils are compound-wound and of the well-known General Electric ventilated type.

The armature core, formed of steel punchings, is rigidly held to a cast-iron spider of substantial proportions by means of numerous dovetails. Effective cooling of the armature is procured by numerous ventilating ducts throughout the core, and also by a novel construction of the end flanges which allow the end conductors to be well separated, and permits a free and natural flow of air between them. The armature winding is of the multiple-drum type, composed of formed coils of bar copper effectively insulated and interchangeable on the same armature. The coils are held in the slots by tough wooden wedges and the end-windings are kept in position by patented sectional binding bands, easily removed or replaced.

The commutator bars are of hard drawn copper of such dimensions as to provide ample wearing depth and liberal creepage distances. The spider, made of cast-iron, is rigidly bolted to the armature spider and the clamping rings are of the best cast-steel. An interesting feature of the commutator construction is the precaution taken to prevent a possible short-circuit from studs or bars to clamping rings. Where the clamping rings extend beyond the commutator bars they are thoroughly insulated with mica and, in addition, extra insulation is molded over the extreme edge of ring and carried well down underneath where it is securely fastened, thus making it almost impossible for grounding to occur at this point.

The brush rigging is of the latest type, employing cast brackets of substantial dimensions to which the individual brush-holders of excellent design are bolted. The resulting construction is strong, rigid and extirely free from movement or vibration, thus obviating the necessity of employing supporting tie-rings passing from stud to stud. Alternate sets of brushes are so placed on the stud brackets that they are staggered around the commutator. By this means the brushes do not track, thus promoting even and uniform wear of the commutator without the use of auxiliary means to obtain this desirable feature.

The present normal capacity of the Boston elevated system is a little over 52,000 kilowatts, all of which is represented by direct-current machines. The remarkable success that has attended the operation of these machines in the power plants of the above company is an indication of the important part that the commutating-pole generator will play in the future in the economic consideration of power problems as regards enlargements to or the building of new power stations for the operation of street railways.

A Valuable Book for the Contracting Engineer.

The H. B. Camp Company, New York city, manufacturer of vitrified clay conduit, has published a book devoted to the use of conduit for electrical subways, which has been prepared by Stephen A. Douglas.

The aim in getting out this edition is to supply a want expressed almost daily by electric light, power, street railway, telephone and telegraph companies which are doing or contemplating underground conduit work. The first portion of the book gives underground construction costs for conduit laid in asphalt or tarred brick, grouted brick or Belgian block, cedar or other wood block in concrete, cedar, cobble, or McAdam, in sand; and conduit in grass plot or under common soil. There is also a complete specification and form of contract for an underground conduit system, which should be of great value to the engineer. A very valuable portion of the book is devoted to diagrams giving data and prints showing sizes of ducts, manholes and hand holes for a complete subway system.

Current Electrical News

DOMESTIC AND EXPORT.

FROM PARIS TO NEW YORK BY WIRELESS—The French Government has begun the installation of an elaborate wireless-telegraph apparatus in the Eiffel Tower, by which it hopes to be able to communicate directly with New York. General Picquart, the minister of war, is convinced that on account of the splendid results attained by the wireless system, by means of which recently messages were sent to Paris direct from Morocco, a distance of about 2,000 kilometres, the establishment of an instrument in the Eiffel Tower would prove most useful as a part of the national defence in time of war.

POWER COMPANY RESTRAINED—A decision has been rendered in the suit brought by the Canadian Pacific Railway Company and the Bell Telephone Company against the Falls Power Company, making permanent an injunction restraining the power company from stringing its wires on certain streets in Welland, Ontario, and directing that company to remove certain poles already placed on the territory in dispute. The Canadian Pacific Railway Company, in constructing its telegraph line between Toronto, Buffalo and Detroit, built through Welland, and for convenience the telegraph wires were strung on the poles of the Bell company. About two months ago the power company sought to string wires on the same streets and it was claimed that the high voltage interfered with the service of the Bell company and the Canadian Pacific.

NEW ORLEANS & SEASHORE AIR LINE INCORPORATED—Announcement has been made that the New Orleans & Seashore Air Line Railway Company has been organized in New Orleans, La., with a capital stock of $1,000,000, for the purpose of building an electric railroad from a point on the opposite side of the river, in Jefferson Parish, to Grand Isle. It is the purpose of the promoters of the company to build a line which will make Grand Isle only sixty minutes' ride from New Orleans, and to so improve Grand Isle that it will become one of the resorts of the country. The charter names Arsene Perrilliat, James W. Porch, William F. Pinkard, John H. Menge, Jr., and Honore Dugas as the first board of directors. The capital stock is to be divided into 10,000 shares of $100 each, $500,000 of this being seven per cent cumulative preferred stock and $500,000 being common stock. It is provided in the charter that the management of the company shall be vested in the holders of the common stock.

TWIN CITY RAPID TRANSIT COMPANY—The income account of the Twin City Rapid Transit Company for the year ended December 31 last shows earnings equal to 8.17 per cent for the $20,100,000 outstanding common stock after the payment of seven per cent on the $3,000,000 outstanding preferred. After the deduction of $506,000 for the renewal fund there remained an amount equal to 5.65 per cent for the common stock. During the year 1906 the earnings for the common stock were equal to 8.32 per cent before the deduction of $482,000 for the renewal fund and to 5.92 per cent after the deduction of this amount. Heavier operating expenses and increased charges and taxes were responsible for the somewhat poorer showing for 1907. The income account follows: Gross earnings, $6,055,743; expenses, $2,980,435; net earnings, $3,075,308; taxes, interest and dividends, $2,438,170; surplus, $637,138; renewal fund; $506,000; net surplus, $131,138 (comparing with $237,682 for 1906). The operating ratio for 1907 was 49.22 per cent as compared with 46.51 per cent for 1906 and 44.53 per cent for 1905.

RECEIVERS AGAIN APPOINTED FOR CHICAGO & MILWAUKEE ELECTRIC RAILROAD COMPANY—For the second time within a few weeks receivers have been appointed for the Chicago & Milwaukee Electric Railroad Company. Judge Grosscup, in the United States Court, made the appointments on application of interests which are said to be favorable to the present management of the company. A receiver was also named for A. C. Frost & Company, a banking firm which has financed the road's bond issues. Mr. Frost is president of the railroad company. The chief liability of the company is said to be a bonded indebtedness of $15,000,000. Floating debts and other liabilities are said to aggregate about one-third as much more. D. B. Hanna, vice-president of the Canadian Northern Railway Company; W. T. Osborne and H. A. Haugan, president of the State Bank of Chicago, are the present receivers. After the first receivership troubles, the company could not sell its bonds to complete the road. The present friendly suit will help to raise the necessary funds.

ANNUAL STATEMENT OF THE PHILADELPHIA COMPANY—The earnings of the Philadelphia Company, which is controlled by the United Railways Investment Company, for the year ended December 31, 1907, were approximately the same as for the previous year. The increase in gross earnings was equal only to 4.76 per cent, while there was a decrease equal to 1.28 per cent in net earnings. The year's charges were less, with the result that the balance for dividends showed an increase equal to 2.38 per cent. After the payment of dividends on stocks of affiliated companies, there was a balance due the Philadelphia Company of $2,628,768, a decrease equal to 3.04 per cent. This amount of $2,628,768 is equal to five per cent on the $6,000,000 outstanding preferred stock and to seven per cent on the $33,240,000 outstanding common good. The dividend rate on the common stock is now six per cent, and with a margin so small there seems little likelihood of an increase in the rate. The United Railways Investment Company owns, according to last figures published, $24,200,000 of the Philadelphia Company's $33,240,000 outstanding common stock. Its revenue from its holdings consequently amounts to $1,452,000, which is equal to five per cent on its own $15,000,000 preferred stock and to 3.62 per cent on its own $19,400,000 outstanding common stock. The income account of the Philadelphia Company for 1907 is as follows: Gross earnings, $19,091,423; expenses and taxes, $12,067,303; net earnings, $7,024,120; other income, $249,365; total income, $7,273,485; charges, $4,186,563; balance, $3,086,922; preferred dividend, $455,053; surplus, $2,631,869; due owners common stock affiliated companies, $3,101; balance for Philadelphia Company, $2,628,768. This figure compares with $2,711,252 for the previous year.

ELECTRIC LIGHTING.

LINTON, IND.—The city electric light plant, leased to S. Parrott, was destroyed by fire on January 26. The plant was not insured.

TORONTO, CANADA—A by-law authorizing the Port Hope town council to proceed with the erection of a municipal lighting plant has been carried.

TWISP, WASH.—Preparations are being made for installing an electric power and light plant at this place early in the summer. A site has been procured.

BAY CITY, MICH.—The council has awarded contracts for machinery for the proposed electric lighting station in the old waterworks building on the west side.

EVANSVILLE, IND.—A ten-year franchise has been granted at Rockport to the Rockport Waterworks and Electric Light Company under which the streets will be lighted.

IONIA, MICH.—The Ionia Water Power and Electric Company has been awarded the municipal lighting contract for Ionia for another year. There are to be seventy-one arc midnight lights at $52.50 each, with $22.50 added for all-night service.

LEBANON, PA.—The Edison Electric Illuminating Company has elected the following officers: John A. Rigg, president; John A. Rigg, W. A. Rosen, Dr. Walter A. Rigg, Richmond L. Jones, William R. McIlvaine, K. A. Fichthorn and Remi Remont, directors.

REXBURG, IDA.—A franchise has been granted the Idaho Power and Transportation Company, giving it permission to erect its lines

through the streets of Rexburg. The company already controls the local power plant. The power will be generated at Idaho Falls.

WILLIMANTIC, CT.—At the annual meeting of the Willimantic Gas and Electric Company the old board of directors was reelected as follows: George A. Lewis, of Boston, Mass.; D. F. Tilley, of Boston, Mass.; C. H. Evans, of Chicago, Ill.; J. F. Church and C. Winfield Noyes, of this city.

AUBURN, NEB.—C. A. Snyder, manager of the Auburn Electric Light and Power Company, has purchased the plant of the Blue Springs Electric Light Company, of Blue Springs. The affairs of the company have been in the hands of the District Court for some time and were ordered sold by Judge Kelligar.

GREENFIELD, MASS.—At the annual meeting of the Greenfield Electric Light and Power Company these officers were elected: President, Joseph W. Stevens; treasurer, George W. Lawrence; clerk, C. H. Keith. Directors: J. W. Stevens, F. O. Wells, C. C. Dyer, W. B. Allen, Philip Cabot and Winthrop Coffin, of Boston; J. G. Mackintosh, of Holyoke.

CORONA, CAL.—The Pacific Light and Power Company, with generating stations on the Kern River, at San Bernardino, Redondo and the Pedley station on the Santa Ana River, has closed a ten-year contract with the Corona Gas and Electric Company to furnish current. The generating stations are all connected so that power can be furnished from each or all.

OSCEOLA, WIS.—At a meeting of the village council a franchise was granted to C. C. Ladd, giving him the exclusive privilege of furnishing electricity for lighting and power purposes within the village limits of Osceola. The power used in generating the electricity will be furnished by the gas engine at the elevator of the Osceola Mill and Elevator Company.

FRESNO, CAL.—A company organized for the purpose of supplying gas, water and electricity for the town of Corcoran has filed articles of incorporation in this city. The following directors are named: E. O. Hanson, of Hollywood; A. H. Potter and R. V. Miller, of Los Angeles, and the following from Corcoran: L. S. Randolph, J. B. Mayer, George Hanna and J. W. Gulberson. Of the $50,000 of stock, $11,500 has been subscribed.

MENOMINEE, MICH.—At a recent meeting of the Menominee River Boom Company a deal was made with Chicago capitalists for the development of Chappie Rapids for the purpose of furnishing Menominee and Marinette with cheap power. It is expected that work on the necessary dams and buildings will be started as soon as possible. The total amount of money necessary to carry the project through will exceed $200,000.

WARSAW, ILL.—Warsaw will be electrically lighted with power furnished by the Keokuk Electric Light Company. E. B. Hillman, the owner of Warsaw's present electric light system, makes the statement that the Warsaw power plant will be dismantled and the dynamos, etc., will be removed to Barry, Ill., where he will rebuild the plant he owns there and equip it with the machinery of the Warsaw plant.

ARVONIA, VA.—Efforts are now being put forth for the early establishment of a large electrical power plant here which will supply power to all the slate quarries in the Buckingham slate field as well as to all the neighboring towns. It is said by those who have the project in hand that the plant will be in working order by the autumn of this year. It is proposed to utilize the water-power on the Slate River in this undertaking.

AMHERST, MASS.—At the annual meeting of the stockholders of the Connecticut River Power Company the following officers were elected: President, Charles Fred Deuel, of Amherst; vice-president, Philip Cabbott, of Boston; treasurer, M. A. Dickinson, of Amherst; clerk, C. W. Hazelton, of Turners Falls. The above officers, together with H. S. Thompson, of Boston; D. P. Abercrombie, of Turners Falls, and E. D. Marsh, of Amherst, constitute the new board of directors.

ST. LOUIS, MO.—A refunding and extension mortgage dated December 1, 1907, by the Union Electric Light and Power Company, to the Bankers' Trust Company, of New York, and the Mississippi Valley Trust Company, of St. Louis, as trustee, has been filed for record. The mortgage secures bonds to be issued by the Union company, the total not to exceed $50,000,000, to bear interest not exceeding five per cent. Provision is made for the immediate issue of $4,000,000 additional bonds for improvement.

NASHVILLE, TENN.—The annual report of Superintendent J. White Pentecost, of the electric light department, has been submitted to the board of public works. The report states that the department is in excellent condition. During 1907, 213 additional arc lamps were installed, making a total of 1,066, besides 2,407 incandescents. Despite the fact that the plant is running in excess of its capacity, it has maintained high efficiency, and the additions contemplated in the appropriation of $100,000 are expected to meet all requirements for the present year and for several years to come.

GOLDFIELD, NEV.—Within sixty days the Nevada-California Power Company will have completed its parallel power line from Bishop to Goldfield. The company has connected up the line from Bishop to the switchhouse at Palmetto, thus completing fifty-one miles of the parallel system. Within thirty days thereafter the line will be pushed into Silver Peak, a distance of forty miles from Palmetto, and then in the succeeding thirty days to Millers Siding. A branch line of the power company already runs from Tonopah to Millers.

TRENTON, N. J.—At a meeting of the State House Commission a contract was awarded to the Public Service Corporation for the lighting of the State House, at five and three-fourths cents per kilowatt-hour, for three years. Heretofore the state paid the Public Service Corporation six cents per kilowatt-hour. Some time ago it was contemplated to erect a new electric light plant at the State House, so as to light the new addition, but it was found that it would require about $23,000 to install the new plant, besides the extra expense to conduct the same. It was then decided to ask for bids.

VALDEZ, ALASKA—An electric light and power plant is soon to be installed at Cordova by a Washington corporation known as the Copper River Electric Telephone and Power Company. The company has filed on several acres of land at the head of Cordova Bay, and has taken up the water right known as Humpback Creek. There is a steep grade to the creek where the water right is located, there being a drop of 600 feet in 1,600. During the winter months there are 600 inches of water available and during the summer as much as 2,000. It is the intention of the company to furnish light for the town of Cordova and to maintain several sawmills at convenient places along the bay. The mills and telephone system will be in operation within sixty days, and by spring the electric plant will be installed.

NORTH ADAMS, MASS.—In order to generate and sell electric power for use in Worcester County and in the towns of Erving, Warwick, Gill and Northfield, in Franklin County, Representative Myer, of Cambridge, has petitioned for legislative permission to construct a twelve-foot dam across the Connecticut River at Gill and for the incorporation of the French King Rapids Power Company. The bill authorizes the erection of a twelve-foot dam about the normal level of the river, with the provision that the crest may be lowered to four feet above the normal level during periods of high water. The petitioners named are: Philip Young, Henry I. Harriman and Joseph O. Proctor, Jr. The same men included in the prospective company, of whom one is County Commissioner George B. Adams, of Adams, already own privileges on the Connecticut at Brattleboro, Vt.

RADFORD, VA.—J. L. Vaughan, president of the Radford Water Power Company, which owns the local electric power-house, the street railway and street lighting equipment, has closed a deal with J. H. Grayson, whereby he has purchased the electric power-house, flour mill, store and several residences owned by Mr. Grayson, at Graysontown. The price paid is said to have been $30,000. The Graysontown power-house furnished power for lighting the town of Christiansburg, twelve miles away, while the lights, wires, etc., were owned by the town of Christiansburg. Mr. Vaughan and his associates have also purchased this property of the municipality, and will now light both Radford and Christiansburg, and furnish what power is needed for manufacturing plants. They will also build an electric line from Christiansburg to Cambria, at which place is situated the Norfolk & Western Railway station.

OBITUARY NOTES.

MR. DANIEL SHAFER, for many years one of the best-known salesmen and engineers in the South, succumbed on Friday morning, January 24, to a sudden attack of pneumonia at the Nashville Hotel, Nashville, Tenn. Mr. Shafer, who was forty-seven years of age at his death, had been associated for the past three years with the Allis-Chalmers Company, of Milwaukee, being attached during a portion of that time to the pumping-engine department, and for the past year as sales engineer of the steam-turbine department. For five years previous to taking his position with the Milwaukee company he was associated with the Hooven-Owens-Rentschler Company, of Hamilton, Ohio, during which time he acted as its southern representative, and was well known throughout that section as an expert on the power equipment of cotton mills. Mr. Shafer was possessed of a striking personality. He was gifted to a remarkable degree with the faculty of making friends. His home was in Wheeling, W. Va., where he is survived by an aged mother, his only living relative.

MR. MARSHAL HALSTEAD, ex-consul to Birmingham, England, and formerly prominent in newspaper circles, died on January 29, at Cincinnati, Ohio, from an operation for appendicitis. He was about thirty-eight years old, and was a son of Murat Halstead, the noted editor and author. Marshal Halstead was a graduate of Princeton University, and after a very prominent career was appointed American consul at Birmingham, England, on December 8, 1897. He resigned from this position on January 4, 1906, and returned to the United States to take care of his father, who was then in very feeble health. Coming to this country, he brought with him several mechanical and structural specialties which have since proved of great value. Mr. Halstead made a careful study of the commercial and industrial conditions of Birmingham, and aided very materially in the development of American foreign correspondence. He was a Mason and Senior Warden of Alma Mater Lodge, and 1,644 of the Grand Lodge of England. He belonged to the Queen City (Cincinnati) Club, and to the Ivy (Princeton) Club. Mr. Halstead was very recently elected to the board of directors of the Lunkenheimer Company. He is survived by a widow, who was Miss Clara Lunkenheimer, of Cincinnati.

ELECTRIC RAILWAYS.

LANCASTER, PA.—The Conestoga Traction Company has been granted a franchise to install its electric road in the borough of Christiana.

ST. LOUIS, MO.—At the annual meeting of the United Railways of St. Louis fifty per cent of the stock voted. The old directors were reelected.

TRINIDAD, COL.—The Stonewall Valley Electric Railway Company has filed a bond mortgage for $500,000. The mortgage is issued by the St. Louis Union Trust Company.

MINNEAPOLIS, MINN.—At the annual meeting of the Twin City Rapid Transit Company M. B. Koon, of Minneapolis, was elected a director, succeeding M. D. Munn, resigned. Other directors were reelected.

HOLYOKE, MASS.—The annual statement of the Holyoke Street Railway Company shows as follows: Gross earnings, $441,637.47; operating expenses, $300,325.36; net earnings, $141,332.11; miscellaneous income, $8,912.96; gross income above operating expenses, $150,245.06.

CHAMBERSBURG, PA.—The J. G. Schaff Electric Company has been awarded the contract for the building and machinery for the new power plant at a meeting of the construction committee of the Chambersburg, Greencastle and Waynesboro Street Railway Company at Greencastle.

COLVILLE, WASH.—Application has been made to the county commissioners by A. E. Baldwin and C. J. Webb for an electric railway franchise over the highways in Stevens County between Kettle Falls and the mouth of the Spokane River. The line will be forty-five miles long.

MINEOLA, L. I.—The Nassau County board of supervisors has granted a franchise to the New York & North Shore Traction Company to extend its trolley line from Foley's Corners, Roslyn, to the city line at Little Neck. The road will go through Manhasset, Great Neck and Thomaston.

DUBUQUE, IOWA—Extensive improvements, embracing the reconstruction of the Dodge Street-Linwood line and the beautifying and modernizing of Union Park, will be made by the Union Electric Company with the advent of spring. The present estimated figure on the contemplated improvements is $50,000.

CARMI, ILL.—Illinois capitalists are said to be planning with eastern financiers to build a trolley line from Olney to Evansville, Ind., the line to tap Mt. Carmel and Grayville and intermediate stations. Several meetings have been held and it is believed the road will be put down some time during the summer.

HOUSTON, TEX.—At a meeting of the commissioners' court the franchise over the Harrisburg road for an extension of the street car line from the city limits to a point near Harrisburg was accepted by David Daly, the local representative of the Stone & Webster syndicate. The street railway company is bound by the terms of the grant to build and complete the line within a period of nine months.

CALUMET, MICH.—Paul P. Roehm, Henry J. Vivian, F. H. Getchell, Arthur H. Friend and Max Ascher have been elected directors of the Calumet & Lac La Belle Traction Company. Mr. Vivian was elected president, Mr. Ascher vice-president, Mr. Friend treasurer and M. A. Gray secretary. The company is organized to build a trolley line between Calumet and Lac La Belle, in Keweenaw County.

LAKE CITY, IOWA—A corps of engineers is working southeast from this city, surveying a proposed interurban line of railway between Lake City and Lanesboro. This enterprise is backed by local capitalists with the intention of ultimately building the road into Des Moines *via* Jefferson, and as the people of Sac City are becoming interested in the proposed road, it will probably be extended to that city *via* Yetter.

ESCANABA, MICH.—At the annual meeting of the Escanaba Electric Street Railway Company John K. Stack was elected as president and general manager to succeed A. R. Moore. Other officers chosen are: O. B. Fuller, vice-president; Attorney I. C. Jennings, secretary and general counsel, and John J. Cleary, treasurer. The board of directors is made up as follows: J. C. Kirkpatrick, J. K. Stack, J. J. Cleary, J. B. Moran and A. R. Moore.

FAYETTEVILLE, N. Y.—Rights of way have been secured for an electric railway from the plaster quarries of the National Wall Plaster Company of the Miller interests to the Erie Canal at a point one-half mile east of where the Orville feeder joins the canal and where the National Wall Plaster Company's plant is now located. The quarries of the Miller interests and those of the National Wall Plaster Company are located in the town of Dewitt, about two miles west of Fayetteville.

GOLDEN, COL.—Poles have been distributed along the line of the Intermountain Railway between Golden and Denver, and the work of electrifying the road will begin at once. According to the terms of the agreement the work is to be completed and cars running into Golden before June 1, although it is expected that electric cars will be run from Denver to Lakewood in the early spring. This will give Golden two electric lines into Denver and will be the means of building up that section of country along the south Golden road. The work is to be done so as not to interfere with the operating of steam trains on the road until it is ready for the new equipment.

FRANKFORT, IND.—The men interested in the Frankfort, Delphi & Northern Traction Company are starting a campaign looking to the early completion of the line between Frankfort and Delphi, the company expecting to build the line into Chicago at a later date. The right of way has been obtained between Frankfort and Delphi, following the line of the old Rossville gravel road through Edna Mills, Prymont and on to Delphi, a distance of twenty-seven miles. The bond issue is about $700,000, or about $25,000 a mile. The company will build a dam at Prymont, where it is said enough electricity can be generated to operate the entire system. The company will also furnish light and power to towns and cities along the proposed line, and has a franchise with the city of Monticello to light the city for a period of twenty-five years.

PERSONAL MENTION.

MR. J. W. ALLING has been elected president of the Southern New England Telephone Company to succeed the late Mr. Morris F. Tyler. Mr. J. T. Moran was elected vice-president.

MR. ROLAND M. LAMB, general manager for the Sea Shore Municipal Railroad Company, Freeport, L. I., formerly the Great South Bay Ferry Company, and originally the Long Beach Transportation Company, which was organized some years ago, has resigned his position. His successor has not yet been named. Mr. Lamb has other interests, to which he will devote his time.

MR. MARSDEN J. PERRY has resigned as president and general manager of the Narragansett Electric Lighting Company. It is announced that pressure of business will prevent Mr. Perry from continuing at the head of the management of the company. No action was taken on the resignation at the meeting, but it is understood that a suitable resolution will be drawn up in recognition of Mr. Perry's services to the company. Mr. Perry is one of the most prominently known central station men in the country. His great executive ability has carried forward the properties with which he has been connected to a very successful condition, and he has been looked upon as a leader in this field for the last quarter of a century.

ELECTRICAL SECURITIES.

Speculative activity dwindled to almost nothing during last week, and notwithstanding the easing of monetary conditions, there has been little demand for new propositions. The hopeful feature of the present season is the decided change in climatic conditions, which has affected the entire north temperate zone and has brought about a drop in temperature which is regarded as extremely fortunate. The recession in bulk of business and the dropping off of railway traffic continue, with indications that the present condition of business will be maintained well into the spring.

Dividends have been declared upon the following electrical securities: Chicago City Railway Company; an extra dividend of 2¼ per cent, payable February 10 to stock of record February 14. Ohio Traction Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable February 1. New York & Queens County Electric Light and Power Company; regular semi-annual dividend of 2½ per cent on the preferred stock, payable February 10. Quarterly dividend of 1¼ per cent on the American Telegraph and Cable Company, payable March 1. Boston Elevated Railway Company; regular semi-annual dividend of 3 per cent, payable February 15. Susquehanna Railway, Light and Power Company; regular semi-annual dividend of 2½ per cent on the preferred stock, payable March 1 to stockholders of record February 18.

ELECTRICAL SECURITIES FOR THE WEEK ENDED FEBRUARY 1.

New York:	*Closing.*
Allis-Chalmers common	5¾
Allis-Chalmers preferred	19
Brooklyn Rapid Transit	45⅜
Consolidated Gas	99
General Electric	118½
Interborough-Metropolitan common	7½
Interborough-Metropolitan preferred	20
Kings County Electric	90
Mackay Companies (Postal Telegraph and Cables) common	50
Mackay Companies (Postal Telegraph and Cables) preferred	61
Manhattan Elevated	127
Metropolitan Street Railway	20
New York & New Jersey Telephone	99½
Western Union	54½
Westinghouse Manufacturing Company	43

Directors of the Consolidated Gas Company have declared the regular quarterly dividend of 1 per cent, payable March 16 to stock of record February 18. Books do not close.

Edwin W. Winter, T. S. Williams, Norman B. Ream and Henry Siebert have been reelected directors of the Brooklyn Rapid Transit Company, to serve for three years.

Boston:	*Closing.*
American Telephone and Telegraph	106
Edison Electric Illuminating	208
Massachusetts Electric	—
New England Telephone	110
Western Telephone and Telegraph preferred.	62½

The Massachusetts Electric Companies has issued its statement for the quarter ended December 1 as follows: Gross earnings, $1,780,074; expenses, $1,320,663; net, $459,411; charges, etc., $436,436; leaving a surplus of $22,975. This figure compares with $75,521 for 1906 and $86,298 for 1905.

Philadelphia:	*Closing.*
Electric Company of America	9¼
Electric Storage Battery common	28
Electric Storage Battery preferred	28
Philadelphia Electric	6
Philadelphia Rapid Transit	16½
United Gas Improvement	77½

Stockholders of the Electric Company of America, at the special meeting in Camden, N. J., voted favorably on the resolution authorizing the management to exchange the stock for American Gas and Electric Company bonds.

The official announcement of a stock dividend and cash assessment ordered by the Philadelphia Electric directors is as follows: "Directors of the Philadelphia Electric Company have declared a stock dividend of $1 per share from the surplus of the company, payable March 2 to stock of record February 20. The dividend will amount to $1,000,000, or 10 per cent of the paid-in capital of the company. The board also called an assessment of $3.50 per share, payable in installments of $2.25 and $1.25, on March 2 and June 1, respectively. The dividend declared may be applied upon the payment of the first installment of the assessment, so that stockholders will have to pay but $1.25 per share in cash on March 2. This is the first call made upon the stockholders for additional capital since April, 1904. Since that time large sums of money have been expended upon permanent improvements and extensions of the company's properties. The gross earnings for the year ended December 31, 1907, are estimated at $4,950,000, against $4,503,878 in 1906 and $4,104,113 in 1905."

Chicago:	*Closing.*
Chicago Telephone	98
Commonwealth Edison	88
Metropolitan Elevated preferred	50
National Carbon common	55
National Carbon preferred	103

The report of the South Side Elevated Railroad for the year ended December 31, 1907, has been issued. This shows as follows: Passenger receipts, $2,021,931; advertising and miscellaneous, $83,261; total gross, $2,105,192. The total operating expenses were $1,459,745, leaving net earnings of $645,447. After deducting interest on bonds, $196,875, rentals paid to Chicago Junction Railway, $9,064, the balance for dividends, $439,508, is equal to 4.2 per cent earned on the $10,323,800 capital stock. The general balance sheet shows total assets of $19,972,445, and liabilities of $18,595,961, leaving a reserve of $1,376,484. The year's total traffic aggregated 40,438,620 passengers, the daily average being 110,791, or an increase over 1906 of 17.47 per cent. December traffic amounted to 3,713,415, a daily average of 119,791 persons, or 25.8 per cent increase. The daily average in January of passengers carried was 112,707, an increase of 20,296. The operating ratio was 69.3 for the year and 74.4 for the month of December. The increase in gross is attributable partly to the normal increase of population, and partly to the Englewood extensions and the New Kenwood branch. The lower rate of increase in net is due to a normal increase in operating expenses and some extraordinary expenses for improvement of structure and operating conditions. The increase in operation expenses is apportioned to various departments as follows: Maintenance of way and structure, $36,097; maintenance of equipment, $24,351; conducting transportation, $142,536; general expenses, $14,241, and loop expenses, $35,249. At the South Side Elevated annual meeting W. R. Linn and Leslie Carter were reelected directors. Wallace Heckman succeeds William B. Walker as a director. C. V. Weston was elected president, also a director and general manager, succeeding the late Marcellus Hopkins.

The Metropolitan Elevated daily average passenger traffic for January was 141,564, a decrease of 8,601.

The Northwestern Elevated's daily January average of passengers carried was 100,392, an increase of 11,760.

NEW MANUFACTURING COMPANY.

NEWARK, N. J.—The Stewart Engineering Company has been incorporated with a capital of $25,000 to do an electrical business. The incorporators are: Shellman T. Stewart, Willard Drinsly and Arthur M. Woodford.

TELEPHONE AND TELEGRAPH.

CINCINNATI, OHIO—The annual meeting of the Cincinnati & Suburban Bell Telephone Company will be held in Cincinnati on February 19.

YARMOUTH, ME.—The plant of the Yarmouth Telephone Company has been transferred to the New England Telephone and Telegraph Company.

CARTHAGE, MO.—The Missouri & Kansas Telephone Company has completed the installation of a $20,000 switchboard. This has a capacity of 1,500 subscribers.

FAYETTEVILLE, N. C.—The Carolina Telephone and Telegraph Company has given out the contract for the erection of an office building of white pressed brick.

READING, PA.—At the annual meeting of the Mountain Telephone Company, H. W. Kemp was reelected president and William Taggert, of Sassamonsville, secretary.

SAVANNAH, GA.—Announcement is made that the Bell Telephone Company will buy out the Georgia Telephone Company, an independent company established ten years ago.

WATERTOWN, N. Y.—The Black River Telephone Company has begun the extension of its lines from Deer River into the village of Carthage, where the company purposes to construct and maintain an exchange.

WAVERLY, N. Y.—At a meeting of the directors of the Ellistown Telephone Company, in Ellistown, the matter of constructing a telephone line north on the Sheppards Creek road was discussed. At present the company leases the right to use the poles of the Lockwood Telephone Company.

LA CROSSE, WIS.—The La Crosse Interurban Telephone Company has purchased the lines of the Vernon County Telephone Company and will consolidate the two companies with headquarters in La Crosse. The Vernon County lines consist of about 600 telephones with exchanges at Viola, Soldiers' Grove and Reedstown.

LEWISTON, ME.—At the annual meeting of the Lewiston, Greene & Monmouth Telephone Company, the following officers were elected: Directors, R. Alden, H. M. Blake, E. Hodgkins, E. R. Jones, J. H. McIlroy, R. C. McIlroy, L. Pettengill, John Durgan and L. D. Mansur. H. M. Blake was elected treasurer, and Lawyer Foster, secretary.

ELK CITY, IDA.—The Elk City extension of the Stites-Elk City Telephone Company has now reached Newsome, the half-way point, and it is expected that the line will be completed to Elk City, Ida., in February. The line is being built by an independent company composed of business men of Stites and other towns served. The equipment is first-class, the line being a copper metallic circuit.

PROVIDENCE, R. I.—Work has been started on improving the Attleboro lines of the Providence Telephone Company. Several new trunk lines are to be added to the Attleboro station and the three-line service is to be installed throughout the town. Four of the new trunk lines will run to Providence, and there will be additional lines to North Attleboro and Pawtucket.

DEXTER, ME.—At the annual meeting of the Ripley Telephone Company the following officers were elected: President and manager, W. H. Farrar; vice-president and secretary, C. E. Tripp; treasurer, C. S. Boynton; directors, C. E. Tripp, F. L. Tibbetts, L. R. Ramsdell, A. B. Parker, W. H. Farrar. The company operates twenty-one miles of line and expects to make a number of additions during the present year.

EPHRATA, WASH.—The Ephrata-Moses Lake Telephone Company, organized at Ephrata a short time ago, has awarded a contract to Harvey Hite for the construction of a line to connect the present line south of Ephrata with the Moses Lake post-office. The line will tap an irrigated district of more than 100,000 acres. The members of the company are: I. N. McGrath, C. Tichacek, Harvey Hite, J. M. Pate, and the firm of Gibbons Brothers & Loving.

JERMYN, PA.—At a recent meeting of the promoters of the new Chapman Lake Telephone Company, J. Nelson Graves, of this borough, was elected president and general manager of the organization. A. B. Winter was made treasurer, while the board of directors is constituted of John M. Graves and Charles F. Baker, of Jermyn; David and Lewis White, of Tompkinsville. The work of constructing the lines has been going on since November and is completed as far as Tompkinsville.

KENESAW, NEB.—The Kenesaw Independent Telephone Company held its annual stockholders' meeting after a most prosperous year's business. It declared a dividend of eight per cent on last year's business and increased the capital stock from $10,000 to $20,000. The following board of directors will serve for the ensuing year: S. A. Westing, president; D. D. Norton, vice-president; E. E. Schultes, secretary; R. H. Coplin, treasurer; E. J. Latta, W. S. Parmenter, A. S. Howard, G. W. Wolcott, Stephen Schultes.

SPOKANE, WASH.—Work on the Government telephone line, sixty miles, which penetrates the Idaho forest reserve, is progressing rapidly, the wire being in use several miles up the middle fork of the Clearwater River. The line is installed by the Forest Reserve Bureau, without cost to patrons. Homesteaders and settlers along the line can secure service, the only requirement being that they purchase their own instrument. Thirty miles of line are in operation. While the line is being erected the same service is building roads and trails which afford easy ingress to the forests.

SPOKANE, WASH.—One hundred and fifty miles of lines will be constructed by the North Idaho Telephone Company, organized at Wallace, with headquarters at Kellogg. The capital stock is $25,000, in 1,250 shares of $20 each. Three thousand two hundred dollars has been paid into the treasury. The stockholders are: D. W. Price, W. W. Papesh, W. F. Goddard, S. L. Shonts, Isaac Babbitt, P. P. Weber, L. W. Gay, Robert Sterling, Benjamin Carrigan, Curtis Lightner, Stanley A. Easton, W. C. Clark and A. M. Nash. The company has received a franchise from the city of Wallace, and will connect the various camps in the Cœur d'Alene mining district and with the Interstate Telephone Company for long-distance work.

SALT LAKE CITY, UTAH—The gross revenue of the Rocky Mountain Bell Telephone Company, one of the companies controlled by the American Telephone and Telegraph Company, and which has passed its quarterly dividend, was for the first six months of 1907 $791,612, an increase of eighteen per cent over the corresponding period of 1906. The gain in subscribers for the same period of 1907 were 1,195. At that time the company reported a surplus reserve of $534,739 to provide against temporary losses caused by storms or other contingencies. During the last fiscal year reported the company showed earnings equal to thirteen per cent on the $2,366,300 stock outstanding. The authorized capitalization of the company is $10,000,000. The company has planned for the building of several exchanges during this year. Several were completed in 1907 and exchange construction in 1906 cost $1,143,000. On June 30, 1907, the company had a total mileage of 66,964 of telephone wire, of which 13,000 miles were underground.

DATES AHEAD.

American Institute of Electrical Engineers. Annual dinner, Waldorf-Astoria, New York city, February 19.

Ohio Independent Telephone Association. Annual meeting, Columbus, Ohio, March 19.

National Electric Light Association. Annual meeting, Chicago, Ill., May 19-22.

LEGAL NOTES.

INDUCTION METER CASE—In the suit of the Westinghouse Electric and Manufacturing Company against Eugene Rumsey and George A. Rumsey, in the Circuit Court of the United States for the Eastern District of Pennsylvania, an injunction has been awarded the former, restraining the respondent from infringing claim 2 of patent No. 531,866; claims 1, 6 and 8 of patent No. 531,867, and claims 5, 6 and 7 of patent No. 548,231.

EDGEWISE CIRCUIT-BREAKER CASE—This suit involved the Wright and Aalborg patent No. 633,772. In the suit, which was brought by the Westinghouse Electric and Manufacturing Company against the Condit Electrical Manufacturing Company, Judge Ray filed an opinion in the United States Circuit Court for the Southern District of New York on January 8, holding that the defendant infringes claims 2 and 5, and will issue a decree accordingly.

NEW PUBLICATIONS.

THE SCIENCE YEAR BOOK—The 1908 edition of the "Science Year Book" has been issued. This is edited by Major B. F. S. Baden-Powell, and contains astronomical, physical and chemical tables, a summary of scientific progress, a directory and biography of men eminent in science, and a diary.

ANNUAIRE POUR L'AN 1908—The year book of the Bureau of Longitudes, Paris, for the year 1908, has been issued by Gauthier-Villars. This contains the usual astronomical information and physical, chemical and engineering tables, and several interesting articles, among which is one by G. Bigourdan on "The Distance of the Heavenly Bodies, Particularly Those of the Fixed Stars," and another by F. Guyou, describing the work of the astronomical school at the Montsouris observatory. The price of this annual is one and a half francs.

CANADIAN ELECTRICAL ASSOCIATION—The proceedings of the Canadian Electrical Association, containing the report of the seventh annual convention, held at Montreal, Canada, September 11, 12 and 13, 1907, have been issued. There are included a number of interesting papers on different electrical topics, among them being "High-Tension Insulators from an Engineering and Commercial Standpoint," by C. E. Delafield; "Present Status of the Carbon and Metallic Filament Incandescent Lamps," by J. M. Robertson; and "The Value of the Nernst Lamp to the Central Station," by A. E. Fleming.

NEW INCORPORATIONS.

SALEM, ORE.—Cottage Grove Electric Company. $50,000. Incorporators: John H. McNary, E. W. Hall and A. Welch.

RALEIGH, N. C.—Shelby Electric and Power Company. $50,000; paid up, $14,000. Incorporators: J. J. McMurry and J. C. Smith.

TRENTON, N. J.—Eureka Power Company, Trenton. $100,000 Incorporators: Theodore G. Kitchen, J. D. McNeal and P. N. Van Fleet. To operate electric plants.

ALBANY, N. Y.—Economy Electric Company, Brooklyn. $25,000. Directors: H. F. D. Kelsey, Freeport, Nassau county; George P. Fall, New York; Donald Bayliss, Brooklyn.

CHICAGO, ILL.—Western Illinois & Iowa Railroad. To construct an interurban railway in Hancock County. $2,500,000. Incorporators: Paul A. Neuffer, H. H. Phillips, James E. Harmonic, Charles J. Horn and Rollo M. Cole, all of Chicago.

HARRISBURG, PA.—Irwin-Herminie Electric Street Railway Company. To build a line from Irwin to Herminie, five and one-half miles. $35,000. Holman R. Lynn, Pittsburg, president and a director. Other directors are: Clarence W. Schenck, A. E. Dubois, Pittsburg; W. B. McCain, Allegheny, and H. C. Mullin, McKeesport.

SPRINGFIELD, ILL.—Red Bud & Belleville Interurban Railway Company, Red Bud. To construct a railroad from Red Bud, Randolph County, through the counties of Monroe and St. Clair to Smithson. $2,000. Incorporators and first board of directors: Conrad Becker, Charles C. Smith, Herman Schryver, of Red Bud; John Keller, Hecker; Ben A. Gundlach, Belleville.

ATLANTA, GA.—The Fitzgerald & Ocilia Electric Railway and Power Company. To operate an electric railway in and between these two growing south Georgia cities, and also to furnish electric lights and power. $50,000. Principal office, Fitzgerald. Incorporators: S. T. Holzendorf and two others of New York; L. C. Holzendorf, of Valdosta; C. P. Holzendorf, of Atlanta; R. I. Kirkland, of Irwin County; C. A. Holzendorf, T. M. Parsons, D. B. Jay and Clayton Jay, of Fitzgerald.

HARRISBURG, PA.—The Standard Gas and Electric Company, of Philadelphia; $25,000; to manufacture and sell both products; signers to the application, S. S. Eveland, Bryn Mawr; Elizabeth A. Reese and Clifford K. Cassel, Philadelphia. Beaver Falls & Koppel and Beaver Falls & Lawrence electric railways, each with $6,000 capital; to build one mile of trolley line at the new town of Koppel, in Beaver County; T. P. Simpson, Beaver Falls, president, with S. L. Tone, C. W. Gibbs, W. J. Horgan and B. S. Johns, Pittsburg, as directors.

INDUSTRIAL ITEMS.

THE NILES-BEMENT-POND COMPANY, 111 Broadway, will be pleased to send its descriptive list No. 15, dealing with second-hand metal-working machinery.

THE AMERICAN STORAGE BATTERY COMPANY, Cambridge, Mass., has ready for distribution complete literature comprising descriptions and reports of tests of its new storage battery.

THE WEBER GAS ENGINE COMPANY, Kansas City, Mo., has ready for distribution its bulletin No. 55. This contains full information on this company's prime mover, and will be sent to those interested upon request.

THE SCHUTTE & KOERTING COMPANY, Philadelphia, Pa., will send to those interested, upon request, its new descriptive literature devoted to water-jet primers for siphon pipes, centrifugal pumps, long suction pipes of piston pumps and air vessels.

THE NATIONAL ELECTRIC LAMP ASSOCIATION, Cleveland, Ohio, through its engineering department, has published Bulletin No. 6B, supplementing Bulletin No. 6, devoted to tungsten multiple lamps and units. These lamps operate at 1.25 watts per candle on 100 to 125 volts.

DOSSERT & COMPANY, New York city, announce that Dossert solderless terminal lugs are used throughout on all the lighting and power panels as well as switchboards installed in the new eleven-story, fireproof Joseph J. Little printing building, New York city, by E. C. Tibbals & Company.

THE FRANK MOSSBERG COMPANY, Attleboro, Mass., has designed and is placing on the market a display stand for wrenches. The company's line of wrenches comprises thirty-two sizes and types, ranging from five inches to ten inches in size. This stand has been devised in order to display these wrenches to the best advantage.

V. C. GILPIN, 120 Liberty street, New York city, is distributing a pamphlet devoted to conduits and fittings. This includes American Conduit Manufacturing Company's enameled steel conduit, Alphaduct Company's flexible non-metallic conduit, Pratt Chuck Company's electro-galvanized pressed-steel outlet boxes, and Steel City Electric Company's conduit fittings.

THE HYATT ROLLER BEARING COMPANY, Newark, N. J., will be pleased to send its new pamphlet devoted to Hyatt roller bearings. This pamphlet gives complete data showing the friction load of shafting in an electrically driven machine shop when equipped with Hyatt roller bearings. The data are taken from official tests made at the Buffalo, Rochester & Pittsburg Railway shops at Dubois, Pa.

THE BRISTOL COMPANY, Waterbury, Ct., has published a new bulletin devoted to a description of its water-level gauges. Air pressure is used for transmitting the motion, and all moving parts have been eliminated except a rubber diaphragm which is permanently located below the freezing point in the water. The recording portion may be located at any convenient distance from the water and can be equipped with either daily or weekly charts of any capacity.

THE OHIO BRASS COMPANY, Mansfield, Ohio, has published a handsome catalogue devoted to the Collin pressure regulating valve. This valve reduces the boiler pressure to any pressure required for heating, cooking, drying or other service. It maintains a uniform pressure, regardless of variation in the initial pressure. It operates low-pressure pumps and engines from high-pressure mains The company will be pleased to send this catalogue and other information upon request.

THE CUTLER-HAMMER CLUTCH COMPANY, Milwaukee, Wis., has reproduced an article from *Cassier's Magazine* for October, 1907, entitled "Electromagnets for Lifting and Handling Materials," in booklet form. This booklet, which is printed in the form of a miniature magazine, traces briefly the development of the lifting magnet and illustrates the different kinds of magnets used for handling pig-iron, metal plates and other classes of material. Copies may be had by addressing the company.

THE STANDARD ELECTRIC ACCUMULATOR COMPANY, 141 Broadway, New York city, announces the placing on the market

of the "Standard" accumulator, based on the Clare patents. The principle employed in this cell is the complete exposure of the active material and its lead electrode in a very thin, strong and porous box of unglazed pottery. Each unit box is about three and one-half inches square and half an inch thick over all. Its sides are porous plates, of which the inner surfaces are reticulated and the outer faces ribbed.

THE BLISS ELECTRIC CAR LIGHTING COMPANY, Milwaukee, Wis., announces that during the year it furnished more than seventy-five per cent of the "Axle Light" equipments for electric car lighting installed on the best cars of the leading railways of the United States, Canada and Mexico. The company's equipments are now being used on the New York Central lines, the Santa Fé system, the Harriman lines, and on a number of other roads. The system is also being used on many Pullman sleeping cars and Pullman private cars.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., in Bulletin No. 4,559, describes and illustrates direct-current motor-starting devices, rheostats and panels. These rheostats contain an improved enclosed type resistance unit consisting of a low-temperature-coefficient resistance wire wound on a strong tube. The unit is treated with a special compound which forms a coating both inside and out, making a strong and solid construction, which is thoroughly baked before being placed in the rheostat. The bulletin shows rheostats with no-voltage release and overload release, as well as rheostats for starting reversible, shunt, or compound-wound, constant-speed motors.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., in the February issue of "Trumbull Cheer," in addition to the usual material written in a lighter and very interesting vein, calls attention to the company's National Electrical Code Standard fuse blocks and fuse holders. The company also states that all standard sizes of its type C switches are now put up in individual paper boxes, which will make them much more convenient for handling on the shelves. It is announced that these switches have been having an unprecedented sale, especially during the last six months, and it is thought that this new feature will help to make the sales still greater.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has published Bulletin No. 63, devoted to "The Standard" direct and alternating-current ceiling, exhaust, bracket and desk fans. These fans are now in their twelfth season. The very general extension of electric service in the residence and outlying districts has brought sixty-cycle, single-phase alternating current into great prominence, owing to its peculiar adaptability for this class of work. The line of alternating-current fans illustrated in this new catalogue has been brought out for use where fans are required beyond the reach of the direct-current mains. Copies of this bulletin may be secured upon request.

THE LEEDS & NORTHRUP COMPANY, Philadelphia, Pa., is publishing a new catalogue devoted to portable testing sets and cable-testing apparatus. This catalogue has been prepared with great care, and should be of considerable assistance to any one in search of information concerning this branch of electricity. In addition to the descriptive matter there is a complete price list which also serves as an index and general guide. Under each instrument is a statement indicating the measurements for which it is intended. Minute directions are given for the use of each instrument for each of the tests for which it is intended, and in the preparation of these directions the company has had the assistance of those who have become very familiar with the application of the tests and the methods pursued. There is a chapter on the general subject of fault location. The explanations have been made as clearly as possible, and the use of mathematics and formulæ has been avoided except where this has been absolutely necessary in order to avoid a cumbrous, misleading explanation.

Directory of Electrical and Allied Engineering and Scientific Societies.

(Published in the Second Issue of Each Month.)

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ORDER OF THE REJUVENATED SONS OF JOVE. C. B. Roulet, Mercury, Dallas, Tex.

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WISCONSIN INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. C. Crowley, Jr., Superior, Wis.

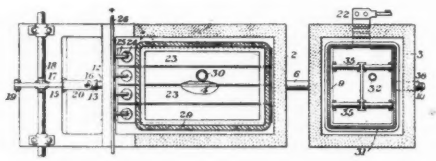
Record of Electrical Patents.

Week of January 28.

877,501. ELECTRIC ALARM ATTACHMENT FOR CLOCKS. Charles Goldsmith, Denver, Col., assignor of one-fifth to Cesare Pinelli, Denver, Col. A programme clock with a cylindrical circuit-closer.

877,537. METHOD OF ELECTROLYZING SALTS. Jasper Whiting, Niagara Falls, N. Y. An electric current is passed through the molten electrolyte to a mass of liquid metal which first acts as a cathode and is then transferred from the decomposing chamber, being replaced simultaneously by a fresh mass of liquid metal.

877,555. TELEGRAPHY. Patrick B. Delany, South Orange, N. J. Code dots and dashes are produced at the transmitting station which are transmitted into signals of a different kind at the receiving station and there converted locally into dot and dash signals.



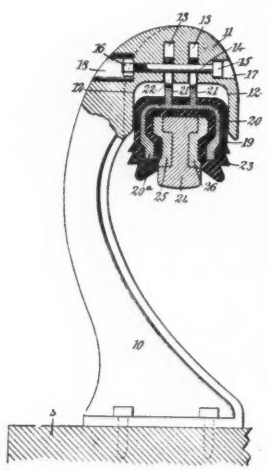
877,537.—METHOD OF ELECTROLYZING SALTS.

877,558. SELF-LUBRICATING TROLLEY WHEEL. Hiram G. Farr, Melrose Highlands, Mass. A wheel with a chamber packed with absorbent material.

877,576. SERIES-PARALLEL POLARITY-CHANGING SWITCH. Edwin S. Lincoln, Brookline, Mass. A triple-pole double-throw switch.

877,656. SPARK COIL. August R. Luschka, Chicago, Ill., assignor to Motor Specialty Manufacturing Company, Chicago, Ill. The combination of a secondary coil with high and low-tension sections and a condenser of annular shape surrounding the low-tension section.

877,684. ELECTRIC-INSTALLATION OUTLET BOX. Wheeler H. Vibber, New London, Ct., assignor to the Gillett-Vibber Company, New London, Ct. A box with a cover adapted to have a lamp directly attached.



877,804.—INSULATOR FOR HEAVY CONDUCTORS.

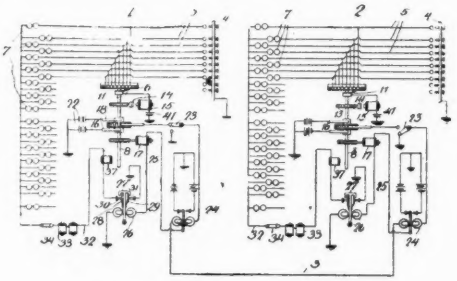
877,705. ELECTRIC-CURRENT CONTROLLER. Albert E. Dion and Charles W. Ball, Ottawa, Ontario, Canada. An overload circuit-breaker.

877,727. TELEPHONE EXCHANGE. Nils E. Norstrom, Chicago, Ills., assignor, by direct and mesne assignments, of one-third to John Anderson, Salina, Kans.; one-third to M. E. Richardson, Sterling, Kans., and one-third to John H. Martin and H. Keating. A discontinuous line and means at the central station for connecting the different sections together.

877,739. MEANS FOR OBTAINING THIN LIQUID DROSS IN ELECTRIC FURNACES FOR METALLURGICAL PURPOSES. Hermann Röchling and Wilhelm Rodenhauser. Völklingen-on-the-Saar, Germany. The furnace hearth is provided with dam-like ridges which force the current to pass through the layer of dross on the metal.

877,784. SHADE FOR INCANDESCENT LAMPS. Edward B. Lewis, Pacific Grove, Cal. A shade-holder with a shell having a plurality of flat divergent parts.

877,804. INSULATOR FOR HEAVY CONDUCTORS. Louis Steinberger, New York, N. Y. An insulator for inverted third rails.



877,822.—PRINTING TELEGRAPH.

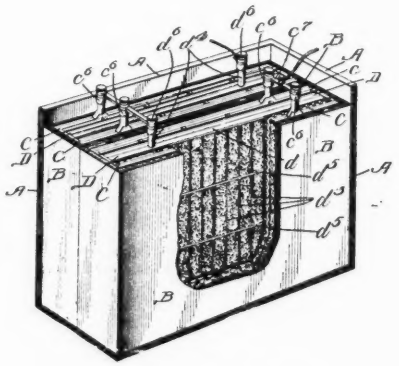
877,817. INSULATED COMPROMISE RAIL JOINT. Benjamin Wolhaupter, New York, N. Y., assignor to the Rail Joint Company, New York, N. Y. The opposite shoes of the joint are provided with overlapping base sections.

877,822. PRINTING TELEGRAPH. John C. Barclay, New York, N. Y. A plurality of character-magnets each operated by a different combination of current pulses.

877,823. PERFORATOR. John C. Barclay, New York, N. Y. A perforator for preparing strip telegraphic messages.

877,844. TROLLEY. August W. Huhsman, Staunton, Ills. The wheel is provided with guards projecting over the trolley wire.

877,857. TELEGRAPH SWITCH. Lewis H. Parcels, Hiawatha, Kans., assignor of one-half to John H. Koger, Willis, Kans. A rotatable switch for bringing into action any one of a group of sounders.



877,889.—STORAGE BATTERY.

877,877. WIRE-RETRIEVING ATTACHMENT FOR TROLLEY WHEELS. William C. Althen, Columbus, Ohio, assignor of one-sixth to William F. Miesse, one-sixth to William N. Gearhart, one-sixth to Benjamin F. Hirt, and one-fourth to John T. Dunnick, Columbus, Ohio. The harp is provided with a guard which is raised when the trolley rope is pulled.

877,887. CONTROLLER REGULATOR. Cyrus P. Ebersole, Keokuk, Iowa, assignor, by mesne assignments, to Electric Service Supplies Company, Philadelphia, Pa. A pawl enforces intermittent movement of the controller handle.

877,889. STORAGE BATTERY. William Gardiner, Chicago, Ill., assignor, by mesne assignments, to Commercial Storage Battery Company, Chicago, Ill. The grid comprises oppositely disposed series of horizontal containing bars and vertical strengthening bars, the latter being provided with inwardly flaring lugs.